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A U S T R A L I A

An investigation of the adaptive functions of overconfidence

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Abstract

The research presented in this thesis explores the question of whether overconfidence provides adaptive benefits. Chapter 1 presents the arguments for three adaptive accounts of overconfidence; that it leads to mental health benefits, increased motivation, and positive social outcomes. It then outlines the forms of measurement needed to properly test these adaptive accounts, and reviews the extant literature. Chapter 2 reports a longitudinal study that tested the effects of two forms of overconfidence (athletic and intellectual) on each of the three adaptive outcomes. Results from this study were mixed, with both forms of overconfidence showing positive cross-sectional associations with mental health outcomes, but largely null effects over time. Overconfidence in sporting ability was strongly associated with increased effort and improvement in sport over time, as well as increased popularity. In contrast, intellectual overconfidence had largely null effects on effort, improvement, or social success over time. Together, the results from Chapter 2 provide evidence that at least one form of overconfidence conferred adaptive benefits to motivation and social success, while results on mental health were more ambiguous. Importantly, this study found no evidence for the oft-cited possibility that overconfidence leads to deleterious outcomes over time.

Chapter 3 extends the investigation of the adaptive functions of overconfidence on social success, testing whether overconfidence helps to win potential romantic partners rather than just friends. In Study 1, overconfident people were perceived as more confident in their dating profiles, and this perceived confidence predicted increased romantic desirability. Study 2 revealed that overconfident people also tend to be perceived as arrogant, however, which counteracted the positive effects of perceived confidence. Study 3 supported the idea that overconfidence might confer an advantage in intrasexual competition, as people were less likely to compete with overconfident individuals due to their perceived confidence and arrogance. Study 4 showed that overconfident raters were themselves more likely to choose

to compete for romantic partners. In Study 5, agent-based modeling incorporating the coefficients from these prior studies suggested that overconfidence facilitates mate acquisition in the presence of intrasexual competition. Together, the results of Chapters 2 and 3 suggests that overconfidence has social benefits in at least some settings, and that these are likely due to the increased perceptions of confidence that it creates.

Chapter 4 provides a discussion of the findings, and in particular explores potential reasons for the different effects of intellectual and athletic overconfidence in Chapter 2, and the different pattern of findings with athletic overconfidence in Chapter 2 and the primarily intellectual measure of overconfidence used in Chapter 3. Future directions of research that could disambiguate the possible explanations are suggested, and further work that could build on the current findings is explored. In sum, this thesis presents several tests of the adaptive functions of overconfidence in multiple settings, finding some support for the idea that overconfidence in humans persists because it provides us with a range of fitness benefits.

Declaration by author

This thesis is composed of my original work, and contains no material previously published or written by another person except where due reference has been made in the text. I have clearly stated the contribution by others to jointly authored works that I have included in my thesis.

I have clearly stated the contribution of others to my thesis as a whole, including statistical assistance, survey design, data analysis, significant technical procedures, professional editorial advice, and any other original research work used or reported in my thesis. The content of my thesis is the result of work I have carried out since the commencement of my research higher degree candidature and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution. I have clearly stated which parts of my thesis, if any, have been submitted to qualify for another award.

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Publications during candidature

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Contributor	Statement of contribution
Murphy, S C (Candidate)	Designed experiments (60%) Created study materials (100%) Collected data (100%) Analysed data (80%) Wrote manuscript (80%)
von Hippel, W	Designed experiments (30%) Wrote manuscript (10%) Provided comments on manuscript (50%)
Dubbs, S L	Designed experiments (10%)
Angilletta, M J	Helped develop plan for agent-based modelling used in Study 5 (20%) Provided comments on manuscript (10%)
Wilson, R S	Helped develop plan for agent-based modelling used in Study 5 (10%) Provided comments on manuscript (10%)
Trivers, R	Helped develop initial hypothesis (20%) Provided comments on manuscript (10%)
Barlow, F K	Analysed data (20%) Wrote manuscript (10%) Provided comments on manuscript (30%)

Contributions by others to the thesis

My primary advisor, Professor Bill von Hippel, provided guidance on theory and study design, and commented on the thesis and the manuscript included. My secondary advisor, Doctor Fiona Barlow, provided guidance on theory and data analysis, and commented on the thesis and the manuscript included.

Statement of parts of the thesis submitted to qualify for the award of another degree

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I wish to dedicate this thesis to the memory of my friend Sean Hudson. He was taken too soon, and is dearly missed.

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Chapter 1: Literature review and introduction

“Facts are stubborn things; and whatever may be our wishes, our inclinations, or the dictates of our passions, they cannot alter the state of facts and evidence” - John Adams

“Reality can be beaten with enough imagination” - Mark Twain

Reality is a harsh mistress

Like all (known) living things, we humans must negotiate a physical world that exists independent of our perceptions. It seems to follow that natural selection should favour perceptions that closely mirror the state of the world. The hawk that accurately represents the position of the field mouse below, or the lion who judges precisely how close it can stalk to a gazelle before being detected, surely have the advantage over their less perceptive kin. So too it would seem that humans, with brains capable of building complex mental models, should have been selected for the accuracy of these models. We would expect our beliefs about the world, and especially ourselves, to reflect the truth as accurately as possible. Any systematic difference between belief and reality should have been relentlessly punished by the mechanisms of natural selection.

The prevalence of overconfidence

And yet, at least when it comes to our beliefs about ourselves, psychological research makes this view of human perception look extremely optimistic. Rather than being relentlessly honed to accuracy, the average person appears to view themselves through chronically rose-coloured glasses, possessing a systematically inflated view of the extent to which they possess valued attributes and abilities. This tendency, referred to herein as *overconfidence* (elsewhere also termed *positive illusions* or *self-enhancement*) can be defined

as judging some aspect of oneself more positively than is warranted by an unbiased assessment of reality.

Decades of research have largely converged on the conclusion that overconfidence is common throughout the population (Alicke & Sedikides, 2009). Studies have demonstrated that the majority of research participants report that they are better than average across a variety of domains, despite the statistical impossibility of this being the case (Dunning, Heath, & Suls, 2004; Guenther & Alicke, 2010). Among other things, the average person is overconfident in their driving ability, (Svenson, 1981), social skills (Swann & Gill, 1997), physical abilities (Dunning, Meyerowitz, & Holzberg, 1989), and job performance (Zenger, 1992). Overconfidence seems to persist even when the costs are both salient and immediate (Ehrlinger, Johnson, Banner, Dunning, & Kruger, 2008; Williams & Gilovich, 2008). While some have argued that overconfidence is a Western phenomenon (Heine, 2005), the weight of evidence suggests that overconfidence is a human universal, though the domains in which individuals are overconfident can differ as a function of cultural values (Gaertner, Sedikides, & Cai, 2012; Sedikides, Gaertner, & Toguchi, 2003; Sedikides, Gaertner, & Vevea, 2005).

While our first thought may be that these instances of overconfidence must be some outlier in human cognition, they appear instead to be representative of how we process information. We exhibit a suite of strategies and biases that seem custom-built to allow us to retain overconfident views of ourselves in the face of a constant influx of realistic information. For a start, we modulate the information we consume in a way that selectively shapes our self-perceptions to be more positive. People work harder to find information refuting hypotheses that reflect negatively rather than positively upon themselves. For instance, they are more likely to question the validity of medical results when the information indicates a pessimistic (relative to optimistic) outcome (Ditto & Lopez, 1992). We seem to use the same criteria when deciding where to direct our attention. For example, in one study,

when people thought a potential dating partner was likely to accept them, they spent equal amounts of time learning about that person's positive and negative attributes. When they were told the person was likely to reject them, however, they spent more time learning about that person's negative attributes. Presumably biased search strategies such as these help maintain a positive (rather than accurate) self-view (T. D. Wilson & Gilbert, 2003).

Once information is encoded, we interpret it differently depending on our motives. When people are told that the length of time they hold their hand in ice water is representative of their self-control, they give lower estimates of the effort it took them to endure the icy water. Presumably, by reducing their perception of the effort the task took, people increase their perceived capacity to endure if they exerted their 'full' effort, thus enhancing their perceptions of their self-control (Fernbach, Haggmayer, & Sloman, 2014). We also update our beliefs more in response to positive information than negative information (Sharot, 2011). For instance, when told we have an unexpectedly low probability of developing cancer, we are more likely to adjust our previous estimate to be in line with this new probability than if it were unexpectedly high. Further, we tend to believe that the best photograph in a set is the one that represents how we 'actually' look, whereas we don't extend this courtesy to others (Williams & Gilovich, 2012).

Finally, we selectively shape our memories as we move further from the mundane reality of the past, seeming to retain more positive and less negative information about ourselves. We have better memory for our good behaviours than our bad behaviours (a bias we don't show for others; D'Argembeau & Van der Linden, 2008), remember our past performance as better than it was (Conway & Ross, 1984; Gramzow & Willard, 2006), and misremember medical results to make ourselves seem more healthy (Croyle et al., 2006).

The costs of being overconfident

The prevalence of these strategies shows that humans can easily maintain overconfident views despite contrary feedback from the world. Does this mean that the costs of having self-views that clash with reality have been overstated?

In fact, as common sense would suggest, research has revealed any number of potential costs of overconfidence. Individuals who are overconfident in their abilities relative to others are overly prone to enter highly competitive markets in experimental settings, generally losing money by doing so (Cain, Moore, & Haran, 2015). Overconfidence has been used to explain similar findings in the real world, such as persistently large numbers of people choosing to become entrepreneurs, despite high rates of failure (Camerer & Lovallo, 1999), and high rates of trading on the stock market, despite the fact that these trades, on average, are a losing proposition (Odean, 1999).

Individuals higher in trait overconfidence are more willing to bet money on the correctness of their answers to trivia questions, despite not actually being more correct, and thus lose more money (Campbell, Goodie, & Foster, 2004; Lakey, Rose, Campbell, & Goodie, 2008). In a more frightening case, medical professionals consistently overestimate the accuracy of their diagnoses (Christensen-Szalanski & Bushyhead, 1981). For instance, even when physicians were 100% certain that their diagnosis of deceased patients was correct, 40% were shown wrong by autopsies (Podbregar et al., 2001). This overconfidence in diagnosis has been cited as prematurely narrowing the hypothesis space and contributing to physician error (Berner & Graber, 2008). In the information technology industry, individuals are overconfident that they can perform computing tasks without making errors, presumably leading to costly bugs down the line (Panko, 2008). Finally, people are overconfident in how long their relationships will last, including that they'll last a lifetime (MacDonald & Ross,

1999). Such overconfidence may lead to costly choices, such as investing in unsuitable mates, hasty marriage, or forgoing a prenuptial agreement.

How to explain the prevalence of overconfidence

The fact that overconfidence results in substantial costs has raised questions about why it is so prevalent. When a seemingly costly trait persists in the population instead of being selected out, evolutionary theorists search for an explanation. The first possibility that should be ruled out, of course, is that the trait simply reflects an unavoidable flaw in an otherwise correctly functioning system.

In line with this possibility, certain situations have been found in which overconfidence would be predicted in humans with accurately functioning perceptual systems making rational (i.e. Bayesian) judgements. For instance, because people know more about themselves than they do about the average other person, they infer others' performances with less accuracy than their own. If they have done very well on a particular task, they should rationally assume that their performance is unusual, and that the average other person will have also done well, but not quite as well (D. A. Moore, 2007; D. A. Moore & Healy, 2008; D. A. Moore & Klein, 2008; D. A. Moore & Small, 2007). Thus, on tasks that are easy where people tend to do well, they will also tend to be overconfident, because they will underweight the extent to which the ease of the task affects them. The corollary to this is that if people have done particularly badly, they should assume others have done less badly, and thus be under-confident. Consistent with this explanation, one of the few instances in which individuals show systematic under-confidence is when they are asked how they compare to others on difficult tasks (D. A. Moore & Healy, 2008).

These accounts, however, cannot explain why overconfidence seems to fluctuate as a function of the motivation to see oneself positively (Beer, Chester, & Hughes, 2013; D. A. Moore, 2007), and the importance of the domain to the self (Brown, 2012). Further, recent

work has shown that individuals are overconfident to a greater degree than can be explained by taking into account their increased knowledge of their own performance (Heck & Krueger, 2015).

If overconfidence is not an unavoidable design feature of human perception, it suggests that some selection pressure maintains overconfidence despite the apparent costs. This possibility leads to a second explanation for the prevalence of overconfidence; perhaps being overconfident is in fact adaptive, due to some functional benefits that offset the costs of holding inaccurate self-views. In this light, the persistence of overconfidence only seems like a paradox because we are missing half the story.

Past theories of overconfidence

The search for the ‘other half’ of the overconfidence story has generated a number of candidate benefits of overconfidence. The most influential of these in psychology can be categorised as ‘intrapsychic’ accounts. According to such accounts, overconfidence can be beneficial because there are direct hedonic benefits to feeling positively about oneself (Alicke, 1985; Brown, 1986) which could buttress people’s inner lives in times of extreme stress (S. E. Taylor & Brown, 1988). Initial support for this argument came from the finding that depressed individuals do not show the pattern of overconfidence prevalent among healthy people (S. E. Taylor & Brown, 1988), and that individuals claiming to be better than average have higher self-esteem (Brown, 1986).

Evolutionary theorists have pointed out, however, that selection neither starts nor ends inside people’s heads (Krebs & Denton, 1997). Mental wellbeing itself is only visible to selection if it has an impact on social or physical outcomes. Thus, to account for the very tangible costs of overconfidence, any proposed benefits must in some way increase the social or physical success of the overconfident. This line of thinking has led to the identification of three broad categories in which overconfidence could work to create tangible fitness benefits.

Functional hypotheses

Mental health

Rather than discard mental health accounts of overconfidence, evolutionary theorists have reframed the hypothesis by viewing mental health as one link in a chain to fitness-relevant outcomes (Haselton & Nettle, 2006; Krebs & Denton, 1997). According to this perspective, having overconfident views might be adaptive due to the tangible fitness benefits generated by intrapsychic phenomena like happiness and self-esteem.

Perhaps the most proximal fitness-relevant benefits of happiness are its benefits to physical health. While the mechanisms of these effects are not well understood, numerous studies have shown that happier, more optimistic patients show better responses to illness and recover better from surgery (Barak, 2006; Chamberlain, Petrie, & Azariah, 1992), as well as having improved immune function (Marsland, Pressman, & Cohen, 2007; Segerstrom & Sephton, 2010).

Happiness has also been found to predict a number of fitness-relevant life outcomes. Studies show that happy people have better job performance, increased incomes, and are more likely to become and stay married (Judge, Erez, & Bono, 1998; Lyubomirsky, King, & Diener, 2005). There are also social benefits to being happy, as others prefer to befriend and be around happy people (Harker & Keltner, 2001). Clearly then, if overconfident people are happier, this in itself might result in fitness-relevant benefits.

Motivation

The second major adaptive benefit of overconfidence may be its effect on motivation. Early theorists argued that overconfident self-perceptions could drive individuals to put in effortful work even when positive outcomes seemed unlikely (S. E. Taylor & Brown, 1988), and to see difficult goals as more achievable. Perceptions of higher ability and

likely positive outcomes drive people to frame situations in terms of gains rather than losses, making them more likely to decide to pursue these goals (Sternberg & Kolligian, 1990), and to work longer and harder on them (Felson, 1984; Weiner, 1979). Thus, overconfidence might cause people to attempt tasks with objectively lower likelihoods of success, or persist for longer or more heartily on challenging tasks.

But why should the willingness to pursue difficult or long shot goals be adaptive? Haselton and Nettle (2006) point out that theories of positive illusions and motivation can be understood in light of Error Management Theory. This theory posits that if errors in a certain direction were reliably more costly across our evolutionary history, we should have evolved mechanisms to bias us towards making the opposite type of error. For instance, it costs little to mistake a stick for a snake, but costs a great deal to mistake a snake for a stick (a small amount of embarrassment and energy wasted on jumping compared to a painful, perhaps deadly bite). Thus, we should preferentially see snakes when there are none.

Error Management Theory applies to motivation because it is often difficult for us to accurately assess our chances of success. The world is full of noisy feedback, and we frequently encounter new challenges. Given this, we can make two types of errors; we can take on challenges at which we will fail, or we can believe that we cannot achieve something that is in fact in our power. Overconfident views of our abilities, if they increase our motivation, will lead to more of the former errors and less of the latter. This pattern of behaviour may be adaptive if it inspires us to tackle tasks with low likelihoods of success, but with probability-weighted benefits that outweigh the costs of trying. Mathematical simulations have confirmed that when the benefits of entering competitive settings typically outweigh the costs of failure; it is adaptive for individuals to over-perceive their abilities and chances of succeeding (D. D. P. Johnson & Fowler, 2011; Ramirez & Marshall, 2015).

As a case in point, unrealistically positive perceptions of the ability to control their disease led HIV-positive men to take more action to maintain their health (S. E. Taylor et al., 1992). An objective assessment of their relatively bleak situation might have led them to give up entirely, but clearly the potential benefits of maintaining health for longer far outweighed the cost of performing health-maintenance behaviours. In a different setting, entrepreneurs' demonstrated overconfidence in their likelihood of succeeding can be viewed as adaptive if the probability-weighted benefits of founding a successful venture outweigh the costs of trying and failing (Cooper, Woo, & Dunkelberg, 1988).

Social benefits

While the previous two accounts have largely focused on the impact overconfidence can have on our own behaviour, the third and final account of overconfidence posits that it may play a direct interpersonal role (Trivers, 2000; von Hippel & Trivers, 2011). This account proposes that overconfidence may be beneficial because of the positive impact it has on others' perceptions of us. As social creatures, the positive regard of those around us is clearly fitness relevant. Individuals whose peers perceive them as capable, likable, and attractive have more opportunities to form alliances with others, gain positions of leadership, and importantly, romantic partners.

However, many of the qualities that individuals value in coalition and romantic partners, such as competence, intelligence, and experience, are not readily assessed and must be inferred from verbal and nonverbal cues. One of the strongest of these cues seems to be confidence. Those who are calmer, more willing to express their ideas, and more relaxed are perceived as being more competent (Carli, Lafleur, & Loeber, 1995; Driskell, Olmstead, & Salas, 1993; Ridgeway, 1987). Further, people are more willing to follow the advice of confident peers, (Zarnoth & Snizek, 1997), and confident individuals are preferred both as leaders (Conger & Kanungo, 1987) and romantic partners (Buss, 2009).

Why should confidence be so persuasive? Confidence can be thought of as an outward reflection of individuals' assessment of their own abilities. To the extent that confidence and ability have reliably covaried in our evolutionary environment, it would be adaptive for individuals to have evolved a tendency to use confidence to make assessments of others' ability. Indeed, a large amount of evidence demonstrates the widespread use of this 'confidence heuristic' (Price & Stone, 2004; Tenney, MacCoun, Spellman, & Hastie, 2007). All else being equal, individuals seem to presume that more confident individuals are more knowledgeable and capable. This tendency emerges as early as age four (C. Moore, Bryant, & Furrow, 1989), and influences the selection of job candidates (Tenney & Spellman, 2011) and financial advisors (Price & Stone, 2004), as well as the tendency to defer to others in decision-making (Locke & Anderson, 2015). Importantly, this heuristic is often not unfounded. When Sniezek and Van Swol (2001) had people choose which advisors to trust, they preferentially listened to those with greater confidence. Because advisors' confidence was indeed related to their accuracy, this decision rule resulted in better outcomes.

Nevertheless, the confidence heuristic also appears to be over-weighted. In the domain of eyewitness testimony, witness confidence affects perceptions of credibility more than any other factor (Cutler, Penrod, & Stuve, 1988), and yet is only weakly related to accuracy (Penrod & Cutler, 1995). Indeed, it appears that in many situations confidence is relied upon unless objective feedback on performance is readily available (Tenney et al., 2007; Tenney, Spellman, & MacCoun, 2008). Ironically, however, people are less motivated to seek out performance information when advisors are confident, making confidence a double-threat (Sah, Moore, & MacCoun, 2013). In fact, even when performance feedback shows that two advisors are equally accurate, people prefer the more confident advisor, despite being aware that the advisor's confidence is higher than is warranted (Price & Stone, 2004; Radzevick & Moore

, 2011).

Such preferences make sense if confidence and ability are generally related in people's experience (or our evolutionary past). People may infer that confidence reflects some knowledge about the advisor's superior ability that simply has not manifested itself in this particular encounter. It is only when individuals' confidence on specific statements is revealed to be dramatically out of line with their accuracy that the confidence heuristic seems to be abandoned (Sah et al., 2013; Tenney et al., 2007, 2008)

If confidence is an outward reflection of our assessment of our own abilities, people who have formed overly positive self-perceptions of their abilities should also feel genuinely confident. If they act in ways that communicate this increased confidence to others, they may benefit from the powerful interpersonal effects of the confidence heuristic. In a sense, overconfident people might 'infect' those around them with their overly positive self-views. The resulting advantages to social pursuits would provide perhaps the strongest fitness-enhancing benefit to overconfidence of the three proposed.

Counter-arguments

Adaptive accounts of overconfidence have not gone unchallenged by evolutionary theorists. The two most potent theoretical challenges to the idea that overconfidence might have evolved due to adaptive benefits draw on signalling theory (Gangestad, 2011) and the difference between biased perception and action (Pinker, 2011).

Biased perception versus biased action

This critique is directed at a proposition fundamental to the motivational account - the idea that overconfidence could be adaptive if it biases our perceptions of success upwards, causing us to tackle highly rewarding tasks that may have a low likelihood of success. The problem with this proposition, it is argued, is that it is only the decision to tackle

the task that is visible to selection, not the process by which the decision was reached. All other things being equal, the same effect could be reached by equipping individuals with an accurate perception of the odds of success, but lowering the threshold at which they are motivated (Pinker, 2011).

In other words, rather than biasing their perception, individuals could achieve the same result by perceiving accurately and biasing their decision rules. This would be adaptively superior in any case where multiple decision rules used the same information, as biasing perceptions of success might influence other decisions apart from the decision to tackle a task. Thus, in the case of a seemingly overwhelming challenge with very low odds of success but a very high benefit to cost ratio, we should coldly assess the odds but nonetheless act as if the odds of success are high.

It seems apparent from introspection that we cannot so easily disentangle the probability of success from our motivation to tackle a task. One need only picture the man who must have a few stiff drinks before he can approach a woman he expects will likely reject him, despite the low fitness cost of any one rejection. Folk psychology also suggests that people see "believing in oneself" as an element conducive to success. When reading descriptions of individuals who are committed to attempting challenging tasks, research participants recommend that these individuals should believe their chances of success to be significantly higher than they actually are (Tenney, Logg, & Moore, 2015). Why, then, do we not react in the purely rational way described by Pinker (2011)?

One possibility is that early humans might have first evolved simple cognitive mechanisms that made effortful tasks with low chances of success seem arduous. Because evolution selects for step-by-step improvements rather than an overall optimum, a further step toward overconfidence could have been an adaptive solution to the problem of tasks that were high-risk, but had high enough value to nonetheless ultimately be worthwhile.

Alternatively, an answer to the calibration problem can be found by positing a role for social observers in the decision loop. Social accounts of overconfidence circumvent the problem identified by Pinker (2011), because when one is trying to spread overconfident views to others, the overly positive belief itself is adaptive to the extent that others find it convincing, independent of its impact on one's own behaviour. Thus, the critique of motivational accounts of overconfidence can be avoided by positing that *we* may not be the only ones we're trying to motivate.

Instead, we may have evolved to bias our perceptions of our abilities upwards to motivate others. As we are a social species, many of our larger endeavours require the combined effort of a number of individuals. The extent to which I can convince others that a collective endeavour is likely to succeed should increase their commitment to my cause, which will increase the chances of success (Suddendorf, 2011). Because the effort of others is not a direct cost to me, I can benefit greatly to the extent that others overcommit to such shared ventures.

In this light, overconfidence that a venture will succeed, as well as other biases, such as overestimating how happy we will be when we achieve a certain goal (T. D. Wilson & Gilbert, 2005) can be seen as salesmanship rather than error. Consistent with such a possibility, some of the highest levels of overconfidence have been reported in individuals for whom convincing others of success can increase the chances of that success. In entrepreneurs, more than 80% of the sample believed their chances of success to be 70% or above, a number far higher than reality (Cooper et al., 1988). Similarly, 96% of venture capitalists overestimate their accuracy in predicting the success and failure of new companies (Zacharakis & Shepherd, 2001).

Another venture in which convincing other people of your chances can directly improve those chances is politics. Interestingly, a study by (Krizan, Miller, & Johar, 2010)

found that people's preference for a given presidential candidate predicts increases in their expectation that that candidate would win, rather than the reverse. This does not make rational sense as a decision making process, but makes perfect sense if we conceive of supporters as salespeople increasing their perceptions of the odds of success in order to recruit others to their cause.

According to this account, it is possible that the adaptive effect of overconfidence on motivation is mostly driven by social effects on the corresponding motivation of others. If increasing my confidence can help me recruit you in a collective effort, then it makes sense that people would systematically overestimate their chances of success. The benefits of overconfidence on my own motivation might be a side-effect, or might have been adaptive given that social pressures had already shaped perceptions of success that were prone to bias.

Honest signals

While a social account of overconfidence can perhaps solve the problem identified by Pinker (2011), this social account of overconfidence is not itself uncontroversial. Some have argued that, in accordance with the principles of honest signalling theory, individuals should not be expected to use a confidence heuristic if overconfident others can exploit that heuristic (Gangestad, 2011). Honest signalling theory proposes that for signals to be used by receivers, they must, on average, carry sufficient valuable information (Grafen, 1990). If a trait carries little or no useful information, receivers will evolve not to use that trait to make judgements.

The first corollary of this theory is that if it were possible for individuals to discriminate signals of overconfidence from those of confidence, they should have evolved the ability to discard the overconfident part of the signal. Where this has been tested, however, individuals seem unable to make this discrimination. Ronay, Oostrom and Lehmann-Willenbrock, (n.d.) found that trained and incentivised recruiting consultants

showed no ability to detect overconfidence in job applicants, while Dufner and colleagues (2013) showed that even students who had been working together for almost a year had little to no ability to detect each other's overconfidence.

If overconfidence cannot be discriminated from confidence, however, signalling theory then suggests that perceivers will evolve to ignore confidence itself as a signal. In other words, if overconfidence made the 'confidence heuristic' useless to observers, it would not have evolved. How, then, could overconfidence enable people to successfully mimic the behavioural signals of well calibrated confidence, while still retaining perceivers' reliance on this signal?

In answer to this question, it is important to remember that honest signalling can tolerate a certain amount of deception, provided that the signal continues to carry value on average. For example, capuchin monkeys offer alarm calls to warn their peers about predators, and this signal is clearly high in value. These animals have occasionally been observed to emit alarm calls in the absence of predators in order to gain preferential access to food (Wheeler, 2009). As the cost of ignoring the signal in the presence of a true predator is high, the signal will continue to be attended to so long as it retains sufficient signalling value.

In the case of overconfidence, it is not hard to imagine factors that would keep people's self-views anchored to reality and ensure the signal of confidence is not overly diluted. First, individuals likely self-limit their own overconfidence to a level below that detectable by others. People tend to negotiate their self-perceptions with close others (McNulty & Swann, 1994; Swann, 2005), and views that are challenged are likely to be abandoned. On a larger timescale, evolution may have calibrated individuals to maintain a level of overconfidence below that which can be detected by others, or, alternatively, below that at which their overconfident perceptions clash too violently with reality (the social

benefits of convincing others that you can fly would be moot the moment your confidence led you off a cliff).

If individuals constrain their overconfidence in this way, we would expect confidence to remain correlated strongly enough with reality to retain its value to observers, even if it is biased upwards on average. Patterns such as this can be seen in the planning fallacy, where people tend to be overconfident in the time it will take them to complete tasks, but their estimates nonetheless remain highly correlated with their completion times (Buehler, Griffin, & Ross, 1994). Further, when individuals are asked to identify pictures of themselves from an array of photos morphed to be more or less attractive, on average they choose a photo that is morphed 20% more attractive, rather than photos morphed to a greater degree (Epley & Whitchurch, 2008). Thus, the self-limiting nature of overconfidence should ensure that confidence remains a signal with a substantial amount of ‘truth value’, reconciling the social hypothesis of overconfidence with signalling theory.

The measurement of overconfidence

The literature has provided a mixed bag of findings for and against all three of these accounts of overconfidence. These mixed results have been driven in part by differences in the way overconfidence is measured in different research traditions (Gramzow, Elliot, Asher, & McGregor, 2003; Kurt & Paulhus, 2008; Kwan, John, Kenny, Bond, & Robins, 2004). The method of measurement in overconfidence is theoretically important, especially to an adaptive account, and so must be explored before the evidence can be properly evaluated.

Some of the earliest research on overconfidence, in the ‘positive illusions’ tradition that sprang up around Taylor and Brown’s (1988) seminal paper, simply asked people to self-report their standing on a number of important traits compared to the population. These studies have generally found positive mental health and interpersonal outcomes for overconfidence (S. E. Taylor, Lerner, Sherman, Sage, & McDowell, 2003; Wojcik & Ditto,

2014; Zuckerman & O'Loughlin, 2006). Nevertheless, although these measures are sufficient to demonstrate overconfidence at the group or population level, a substantial component of the variance in these self-ratings could be due to genuine differences in the extent to which people possess positive traits (Colvin & Block, 1994; Colvin, Block, & Funder, 1995). As self-reports of positive traits alone cannot separate truth from fiction, any purported benefits of overconfidence using this measure could be due to genuine individual differences.

Some attempts have been made to sidestep this problem by developing self-report questionnaires designed to tap self-reported traits that were so positive that anyone claiming to have such traits must be overconfident. Examples include never having felt anger or never having sworn in one's life (Balanced inventory of desirable responding (BIDR); Paulhus, 1988). Studies using this measure have generally found overconfidence to be associated with positive mental health outcomes, while the association with social outcomes range from positive to negative (Bonanno, Field, Kovacevic, & Kaltman, 2002; Bonanno, Rennie, & Dekel, 2005; Goorin & Bonanno, 2009; Gupta & Bonanno, 2010; Paulhus, 1998; Yan & Bonanno, 2015). These questionnaires reduce the problems associated with a pure positive self-perception measure, but the behaviours described are not technically impossible. If individuals make lenient interpretations of the scale, variance in these self-reports may still tap genuine variance in the quality being measured (Paulhus, Harms, Bruce, & Lysy, 2003). Further, because these questions tend to tap highly socially desirable responses, it is questionable how much responses represent self-presentation concerns rather than genuine overconfidence.

Others have attempted to make inferences about overconfidence using measures of narcissism. However, in addition to suffering from the same self-report issues (a typical item on the NPI, "everybody likes to hear my stories", could surely index some genuine variation in the quality of one's stories), overconfidence is conceptually and empirically quite distinct

from narcissism. Narcissists tend to see themselves in an overly positive light, but the construct also encompasses a social style of exploiting others, demanding attention (Ames, Rose, & Anderson, 2006), and potentially possessing a fragile ego (Jordan, Spencer, Zanna, Hoshino-Browne, & Correll, 2003). None of these things are necessarily true of an overconfident person - indeed, research has shown that while overconfidence correlates with the self-admiration component of the NPI, it does not correlate with the exploitative and entitlement dimensions (Carlson & DesJardins, 2015).

Social criterion measures

The first attempts to separate overconfidence from well-calibrated positive self-views used as a criterion the ratings of others, usually close friends or trained observers (Colvin & Block, 1994; Colvin et al., 1995). The reasoning behind this form of measurement is that observer ratings of an individual, especially when collated, will likely converge on the objective reality of that person. The extent to which a person perceives themselves more positively than these external ratings can be taken as their level of overconfidence.

Research in this tradition has tended to provide a negative picture of overconfidence. While most studies have found that overconfidence is associated with self-reported well-being (Bonanno et al., 2002; Kwan et al., 2004; Paulhus, 1998; Robins & Beer, 2001), when adjustment is rated by independent observers, the story is much bleaker -- overconfident individuals are rated as lower in adjustment by trained clinicians (though see Bonanno et al., 2002; Colvin et al., 1995; Kwan, John, Robins, & Kuang, 2008) and friends (Dufner et al., 2013; Kurt & Paulhus, 2008). This tradition has also hinted at other negative effects of overconfidence, with overconfident individuals performing worse on group assignments (Kwan et al., 2004) and overconfident military cadets achieving worse leadership evaluations (Lönnqvist, Leikas, Verkasalo, & Paunonen, 2008).

By far the most negative results found with this measure have been on social outcomes, with studies almost universally characterising overconfidence as socially harmful. When measured in this manner, overconfidence predicts lower ratings of social skills and higher ratings of hostility and defensive behaviours (Colvin et al., 1995; Kwan et al., 2008), as well as being seen as disruptive and dislikeable in the workplace (Cameron Anderson, Ames, & Gosling, 2008), and less accepted by peers (Cameron Anderson, Srivastava, Beer, Spataro, & Chatman, 2006). Findings in this line of research have also shown that even when overconfident people make a positive initial impression, this quickly sours as people get to know them (Paulhus, 1998). Collectively, these results have led some to characterise overconfidence as a maladaptive coping pattern that, even if it conveys an initial intrapsychic boost, will inevitably result in negative outcomes (Colvin et al., 1995; Robins & Beer, 2001).

Before continuing, however, it must be noted that this method of measuring overconfidence is unsuited to testing the adaptive hypotheses for several key reasons. The most prominent of these is that by measuring overconfidence as the discord between self-perceptions and observer-perceptions, these studies capture only that portion of overconfidence that has not proved effective in convincing others. To the extent that the social hypothesis of adaptive overconfidence is correct, ‘successfully’ overconfident individuals would not be characterised as overconfident in these studies, as their peers’ ratings of them would match their own. As a consequence, it is not at all clear how the overconfidence that is captured in these studies relates to an individual's level of ‘true’ overconfidence. Thus, although these studies speak volumes about what happens when we perceive ourselves more positively than *others* perceive us, they say little about the question at hand - what happens when we perceive ourselves as better than we *are*.

Objective criterion measures

Because social criterion cannot be used as a measure of ‘true’ overconfidence, the standard form of measurement in tests of the adaptive accounts of overconfidence has been to compare an individual’s self-report to some verifiable criteria. This most often takes the form of an objective measure of a trait or ability, such as an intelligence test, against which self-report can be compared (Dufner et al., 2012). Other measures have used a ‘ground-truth’ criterion that can be independently verified, such as an actual photograph of an individual (Epley & Whitchurch, 2008). One questionnaire has been developed which asks participants for their familiarity with a series of ‘cultural items’, some of which are known to the experimenter as foils that do not exist. Because the truth is known, the subject’s claims of familiarity with false items can measure overconfidence (Over-claiming questionnaire (OCQ); Paulhus et al., 2003). In either case, this method overcomes the earlier problem with self-report measures by anchoring them to an objective criterion, while avoiding the problems inherent in using observer ratings as a social criterion. Such measures assess perceptions of the self that are ‘more positive than an unbiased assessment of reality’ and so can be used to test the effects of ‘true’ overconfidence.

Existing empirical work

Having identified appropriate measures to test the different hypotheses, it is now possible to consider the relevant evidence.

Cross-sectional studies

On the mental health front, the findings appear mostly positive. In schoolchildren, overconfidence in academic achievement (compared to grades) was associated with higher self-esteem and wellbeing across Israeli and Singaporean samples (Kurman & Eshel, 1998; Kurman & Sriram, 1997), though not with teacher-rated adjustment. Overconfidence in

vocabulary skills has been associated with higher self-esteem, life satisfaction, positive affect, and lower levels of depression (Dufner et al., 2012). Participants who score higher on the OCQ have higher levels of self-esteem (Paulhus et al., 2003). However, one set of studies found curvilinear effects, such that accurate perception was associated with higher self-esteem and lower depression than either overconfidence *or* underconfidence (Kim & Chiu, 2011).

Little work has been conducted outside the domain of intelligence and academic ability, however, and here the results are more mixed. While Epley and Whitchurch (2008) found that individuals who identified attractively morphed photos of themselves as representing their own face had higher implicit self-esteem, this was not the case for explicit self-esteem. Gabriel, Critelli and Ee (1994) also found that although overconfidence in intelligence predicted self-esteem, participants' overconfidence in their attractiveness (compared to average ratings of the attractiveness of their photographs) did not predict explicit self-esteem.

Cross-sectional work cannot address whether overconfident individuals sustain motivation over time, but several studies have shown relationships that hint at short-term effects on engagement and motivation. Individuals who were overconfident on one math test also achieved higher grades on a subsequent different math achievement test, perhaps indicating an increased willingness to tackle the problems (Stankov, Lee, Luo, & Hogan, 2012). Parker, de Bruin, Yoong and Willis (2012) found that individuals who were overconfident in their financial skills compared to a test of financial aptitude reported planning more for retirement, suggesting that they were more motivated to tackle this potentially intimidating task. Finally, participants who were led to be overconfident in their ability to solve *Where's Waldo* tasks persisted longer at these tasks, although they were no more successful in finding the elusive Waldo (Tenney et al., 2015).

On the social front, a growing body of research has demonstrated the ability of overconfident individuals to convincingly convey competence to others. Researchers found that peers perceived students who were overconfident in their ability to achieve high grades as more capable of achieving these grades, independent of true ability (Lamba & Nityananda, 2014). Studies have also shown that in dyadic tasks, task partners perceived individuals who were overconfident in their geographic knowledge as more competent, and consequently accorded them more status in the dyad (Anderson, Brion, Moore, & Kennedy, 2012; Kennedy, Anderson, & Moore, 2013). Further, when led to be overconfident using false feedback, overconfident participants were still perceived as being more competent and received more status, indicating a causal relationship (Anderson et al., 2012). This effect appears to be due to overconfident individuals emitting more of the behavioural cues that independent raters use to judge competence, such as speaking more and using a confident vocal tone (Anderson et al., 2012). Additional work has tested these effects of overconfidence in a real-world setting, and found that job candidates who were overconfident in their ability to answer general knowledge questions were perceived by professional recruitment consultants as being more decisive, adaptive, and better leaders (Ronay et al., n.d.).

In a somewhat different domain, (Dufner, Reitz, & Zander, 2015) found that students who were overconfident in their academic abilities were nominated more frequently for several social roles by classmates. The strongest effects were found when nominating someone they would ask for help or would like to work with, though there were also some positive effects when nominating individuals as friends. In a different study, (Dufner et al., 2012) found that individuals who were overconfident in their vocabulary were rated as more likable, though not more agreeable, by their peers. Thus, cross-sectional studies seem to

indicate that overconfidence conveys increased competence, at least in the relevant domain, and that it also has status-enhancing effects.

Longitudinal studies

The cross-sectional evidence provides at least initial support for each of the adaptive accounts of overconfidence. But what about the claim that the harsh light of reality will wither the overly positive perceptions of overconfident individuals, and even if they are initially more motivated, better adjusted, and socially successful, this will collapse over time? Alternatively, it is possible that overconfident people will maintain their social gains over time as they continue to project the signals of positive internal traits, their overconfidence will motivate them to work harder towards difficult goals, and their mental wellbeing will be bolstered and reinforced by their positive self-views and continued success. Clearly these two competing hypotheses can only be assessed with longitudinal data.

The motivational hypothesis has thus far been addressed only in the context of academic achievement outcomes. Two studies have shown that students who are overconfident in their academic ability show increased academic performance from one semester to the next (Blanton, Buunk, Gibbons, & Kuyper, 1999; Wright, 2000). However, Robins & Beer (2001) found that individuals who reported overly positive self-views of their academic ability compared to their GPA and SAT scores showed decreased involvement in the academic domain over time, and that overconfidence did not predict improved GPA across an undergraduate degree nor increased graduation rates.

One line of work has shown that students who exaggerate their GPA in self-report measures often go on to achieve higher GPAs (Gramzow et al., 2003; Gramzow, Johnson, & Willard, 2014; Gramzow, Willard, & Mendes, 2008; Willard & Gramzow, 2009), but since most students surely know their true GPA, it is unclear whether this is a measure of

overconfidence. This measure has been described as a form of goal projection (Willard & Gramzow, 2009), and thus is not considered further.

In terms of mental well-being, Dufner and colleagues (2012) found that individuals overconfident in their intelligence increased in self-esteem and decreased in depression over the course of eight months, while further work showed that individuals overconfident in their intelligence increased in subjective well-being over the course of nine months (Dufner et al., 2015). However in the study by Robins and Beer (2001), overconfidence predicted decreases in self-esteem over the course of a college career.

For social outcomes, longitudinal work has again focused on academic settings in assignment groups or classrooms. Lamba and Nityananda (2014) found that the positive effects on perceptions of ability were retained after 6 weeks of acquaintanceship, though overconfidence did not predict changes in perceptions over time. Anderson and colleagues (2012) found that scores on the OCQ before a class started predicted peer ratings of status and peer-assigned grades 7 weeks later. Dufner and colleagues (2012) found that psychology students in assignment groups were rated as more likable over an eight-month period by other group members to the extent that they were overconfident in their intelligence. A second study further found that overconfidence in intelligence predicted increases in a composite measure of social nominations (i.e. helping, working with, friendship) over time (Dufner et al., 2015).

Summary

While the cross-sectional work on overconfidence using criterion measures has mostly been positive, the longitudinal evidence is more tempered. Mixed results have been reported regarding mental health and achievement outcomes. Although social outcomes have generally been positive, these have focused primarily on competence or status ratings in small groups oriented around the trait on which individuals are overconfident. Further,

measures have varied widely across studies, making it hard to interpret differences in findings across different domains. In Chapter 2, I address this gap by examining the various hypotheses in the context of a single study with a unified measurement approach.

Chapter 2: A longitudinal test of the effects of overconfidence

Introduction

While the longitudinal work presented thus far provides initial evidence that is supportive of adaptive accounts of overconfidence, the body of literature remains relatively slim, and it is hard to make a conclusive determination of the role of overconfidence in mental health, motivation, and social success for several reasons. First, the findings differ across the three domains, with mental health outcomes and motivational accounts receiving mixed support, and social outcomes thus far appearing uniformly positive. Nevertheless, social outcomes were not tested in the main study described in Chapter 1 that reported negative findings (Robins & Beer, 2001), making it unclear whether this difference represents differential effects of overconfidence across domains, or a difference in study design. Robins and Beer (2001) followed students across their entire undergraduate careers, while no other study has followed participants outside the bounds of a single (academic) year (Blanton et al., 1999; Dufner et al., 2012, 2015; Wright, 2000). Do the negative outcomes reported by Robins and Beer (2001) reflect worsening outcomes over a longer time frame, sample or measurement differences, or are they simply an anomaly? It is impossible to tell without testing all three hypotheses in the same sample on a similar timeframe.

Second, the existing research has consisted entirely of overconfidence in intellectual domains (academic ability, intelligence, and intellectual task performance). This is particularly problematic given that the single cross-sectional study to test the effects of overconfidence in multiple domains found that overconfidence in intelligence was positively associated with mental health while overconfidence in attractiveness was not (Gabriel et al., 1994). Thus, while some evidence has accrued to suggest that overconfidence in intellectual domains may be associated with increased future performance and better social outcomes, it would be premature to infer that other forms of overconfidence have the same effects.

There are also measurement issues common to the existing body of work that may temper the generally positive findings reported. With the exception of the OCQ used by Anderson and colleagues (2012), all of the longitudinal work thus far has assessed self-ratings with Likert-style scales. However, Kwan and colleagues (2004) have pointed out that this does not separate overconfidence from the ‘perceiver effect’, which is the tendency of some individuals to rate people in general, including themselves, more positively. For instance, individuals who value relationship harmony tend to rate themselves more positively on all traits, but this self-enhancement is no greater than the enhancement that they show in their ratings of others (Kwan et al., 2004). Thus, when using Likert scales, what appears to be overconfidence may instead partly be individual differences in the tendency to perceive everyone (including the self) positively. To address this problem, it has been recommended that overconfidence be measured by rating one’s own ability on a percentile scale relative to peers. This controls for perceiver positivity effects by ensuring that the scale is specifically comparative (Kwan et al., 2004). Unfortunately, none of the longitudinal work thus far has used such a percentile scale to generate overconfidence scores.

Further, although several studies have shown that overconfidence in intellectual domains leads to increased performance, there has been little investigation into the mechanism by which this happens. While increased effort driven by high performance expectations has been suggested as the mostly likely mechanism by which overconfidence might work (Wright, 2000), this has yet to be tested. It is possible instead that any performance effects of overconfidence are via reduced stress in the face of examinations, or some other mechanism. At the moment there is no way of knowing.

Finally, and perhaps most importantly, while all longitudinal studies thus far have shown positive social outcomes for overconfident individuals, the domains within which these effects have been tested are relatively limited. Overconfident individuals seem to be

perceived more positively and accorded more status by their peers over time, but this effect has primarily been demonstrated within assignment work groups (Anderson et al., 2012; Dufner et al., 2012). Dufner and colleagues (2015) extended this finding to show that academically overconfident children were nominated more by their classmates over time, but this effect emerged on a composite measure that is heavily influenced by nominations for someone who would be good to ‘ask for help with work’ or to ‘work with on a project’.

It seems relatively well established from cross-sectional work that overconfidence conveys competence to others and increases status in groups oriented around the domain in which an individual is overconfident. This is an important adaptive outcome in itself. However, if, as the social account suggests, overconfidence helps people project increased confidence to others, it might serve a much broader social function than simply boosting our perceived status or competence. As mentioned earlier, people infer numerous positive traits from the presence of confidence. People trust those who appear confident (Snizek & Van Swol, 2001), and desire confidence in those with whom they enter close relationships (Buunk, Dijkstra, Fetchenhauer, & Kenrick, 2002).

Thus, if overconfidence does increase our ability to convey confidence to others, it should also improve our ability to increase our popularity by building friendships and coalitional ties. Status and popularity are very different social outcomes, and one does not necessarily imply the other (Carlson & DesJardins, 2015). To evaluate the full scope of the social account of overconfidence, then, social outcomes that tap popularity and extend beyond those influenced directly by competence must be tested. Ideally, the effect of overconfidence should be tested with measures that capture social outcomes as reflected in everyday life, outside of a work-group context.

The present study aimed to address each of these issues, by testing all three of the potential adaptive outcomes of overconfidence in a longitudinal student sample. As well as

intelligence, overconfidence in physical ability was also measured, and both were captured using percentile measures. The study includes measures of effort to test whether effort explains any association between overconfidence and positive outcomes. Most importantly, the study measures social outcomes in a real-world setting by using social network analysis to quantify measures of popularity and social closeness directly from the actual day-to-day friendship networks of entire cohorts of students.

Method

Participants

Participants were 1001 boys who attended a large private boys school in Australia (two cohorts of Year 8 students [$n = 208$ and $n = 157$], and one cohort each of Year 9 [$n = 211$], Year 10 [$n = 218$], and Year 11 students [$n = 207$]). The median age was 14 at Time 1, with a range from 12 to 17 years.

Design

The study was conducted over a three-year period, with each Wave of data collected toward the end of the school year. At each Wave, surveys were distributed to students while they were in their various classes, mostly as links to digital surveys to be completed on laptop computers, but occasionally supplemented by paper questionnaires depending on testing circumstances. The bulk of the data was collected during the first two Waves, but the second cohort of Year 8 students, who entered high school and were surveyed for the first time during the second Wave (making this their Time 1), were surveyed again at a third Wave to enable the testing of longitudinal predictions. The dataset thus contains data for five cohorts of students at two time-points each. The measures for this research project were interleaved with other instruments that were part of a larger research project contracted by the school.

Data were also provided from the school administration regarding students' athletic performance scores, visits to the school counsellor, cumulative grade point averages (GPAs), and individual class grades and teacher-rated effort scores for each class during the first two years tested. Because academic data from the school at the third Wave has not been made available, the second Year 8 cohort does not have academic outcome measures.

Measures

Note: To preserve anonymity, where questionnaire items referred to the school by name, the school's name is replaced with [school].

Sporting ability. Sporting ability measures taken in the course of standard physical testing were provided by the school. It was the intention of the school to take these measurements for all students in all Years, but these intentions were not achieved due to staffing shortages. Thus, the sporting ability measures were only available for the two Year 8 cohorts and the Year 9 cohort at Time 1, and for the first cohort of Year 8 students at Time 2. At Time 1, the sporting measures included students' speed on a 40 metre sprint, speed to run the Illinois Agility Test (which requires participants to follow a specific path through a series of cones), maximum vertical jump height, and maximum number of repetitions performed on a thoracic pull test. At Time 2, the thoracic pull test was replaced by a similar test using push-ups. The sporting measures were each standardised and averaged together to form a reliable scale ($\alpha = .85$ at both time points), which I refer to as *sporting ability*.

Intelligence. Intelligence was measured using the Allwell Test of General Reasoning (hereafter the "Allwell"), which tests verbal and numerical skills and is used by some Australian schools to determine the award of ability-based scholarships. The test was administered by the school at different time points, but always before the Time 1 measurement of the questionnaires.

Intelligence and Sporting Overconfidence. As part of the surveys they completed at the end of each year, students were asked to rate how they compared to other members of their class in the categories of Intelligence and Sport. Participants were asked to use a percentile slider to indicate where they fell in each category, where 0 was described as “At the very bottom, worse than 99% of my peers at [school]” and 100 was described as “At the very top, better than 99% of my peers at [school]”

Mental health measures. As part of the surveys, students completed four different measures of mental health. First, they completed the Single Item Self-Esteem Scale (Robins et al. (2001): “I have high self-esteem” (scale ranging from 1, Strongly disagree to 4, Strongly agree). Second, they completed the Student version of the Satisfaction with Life Scale (Diener, Emmons, Larsen, & Griffin, 1985): e.g. “my life is just right” on a 4 point scale ranging from Never to Almost always ($\alpha = .89$ at both time points). Third, they completed the Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983), which asks how students have been feeling over the last week, and has separate Anxiety (e.g. “I get sudden feelings of panic”) and Depression (e.g. “I feel as if I am slowed down”) components, on a 4-point scale ranging from Most of the time to Not at all. For anxiety, α was .82 at Time 1 and .85 at Time 2, while for depression, α was .70 at Time 1 and .77 at Time 2. Finally, students completed a shortened 10-item version of the UCLA Revised Loneliness Scale (Peplau & Cutrona, 1980;): e.g. “I feel isolated from others” on a 4-point scale ranging from Never to Often ($\alpha = .86$ at both time points).

At Time 1, the school also provided records of visits to the school counsellor. These were coded to remove compulsory visits due to behavioural incidents so as to mainly capture students voluntarily seeking counselling.

Engagement. To measure engagement with the school as a form of general motivation, students filled out the Identity subscale of the Collective Self-Esteem Scale

(Luhtanen & Crocker, 1992) with the name of the school inserted as the reference group (e.g. “Being a [school] student is an important reflection of who I am”) on a 7-point scale ranging from Strongly disagree to Strongly agree ($\alpha = .77$ and $.80$ at Time 1 and Time 2, respectively). Students also self-reported whether or not they engaged in nineteen co-curricular activities offered by the school. Twelve of the nineteen co-curriculars were sport-related, so a separate sporting curricular measure was also calculated from this subset. These measures were highly right-skewed and so were subjected to a square root transform.

Academic Effort. Teachers graded student effort on a five point system from “Significant Improvement Needed” to “Excellent”, which was available for all classes. The effort ratings for a calendar year were averaged to form an effort score for each student at each time-point (Intra-class correlations for effort ratings at Time 1 and Time 2 were $.39$ and $.36$, respectively)

Academic Outcomes. Cumulative GPA was available for all students at Time 1. The GPA for the single year after the first Wave of data collection was calculated as an outcome measure at Time 2. This was available for all students except the second cohort of Year 8 students.

Sporting Effort. At Time 2 only, students were asked to respond to the question “how many hours have you spent exercising and/or playing sport/training in a typical week?” in whole numbers.

Popularity (Social Networks). Popularity was measured using indices calculated from social network analysis. This analysis builds networks by treating individuals as nodes, with ties between individuals represented by links connecting these nodes (Marsden, 1990). To model social life within the school, students were presented at each time point with a question that asked them to nominate up to 10 of their “closest friends in [school].” The names students gave were then matched to a school roster and converted to student ID

numbers. Only friend nominations that could be matched to other students in the school were counted (over 90% of the names given in each cohort). The vast majority of friends named were within the same cohort as the naming individual, so separate networks were created for each cohort.

To create the networks, directed links were used (Scott & Carrington, 2011), forming a connection from each student who responded to each student they named as a friend. Where these nominations were reciprocated, links travelled in both directions. Within each of the five networks (one for each cohort) a number of social network measures were then calculated from these friendship nominations. Four ‘local’ network measures of friendship were computed; *in-degree*, the number of students who named a participant as a friend, *out-degree*, the number of friends a student named, *degree*, the sum of in-degree and out-degree (Freeman, 1979), and the *percentage of mutual ties*, the fraction of times a student was named in return by someone he had named who had also taken the survey at that time point.

Three ‘global’ network measures of popularity were also calculated. The first, *number of triangles*, is a measure of how many triadic closures were formed by a student’s friendship ties (i.e. how many pairs of a student’s friends were themselves friends). Triadic closures have long been theorised to represent especially strong friendships (Granovetter, 1983), so this measure captures not just the number but also the quality of each student’s friendships. A second measure calculated *closeness centrality*, the inverse of the average number of steps from each participant to each other participant in the network (Freeman, 1979; Marsden, 1990). Closeness centrality is a measure of the extent to which a student is well connected within the network, measuring the ease with which he could reach any other person through friendship ties. For closeness and number of triangles only, the network was treated as undirected (creating links between each student if either named the other) as this creates more stable scores. The final measure, *Page-Rank*, is calculated using the same

algorithm that indexes the popularity of webpages. This algorithm is a combination of the number of ties incoming to each individual weighted by the number of ties incoming to the individuals at the source of those ties (and so on). It can be thought of as the amount of time a person would spend with each student in the network if ties between individuals were perpetually followed at random.

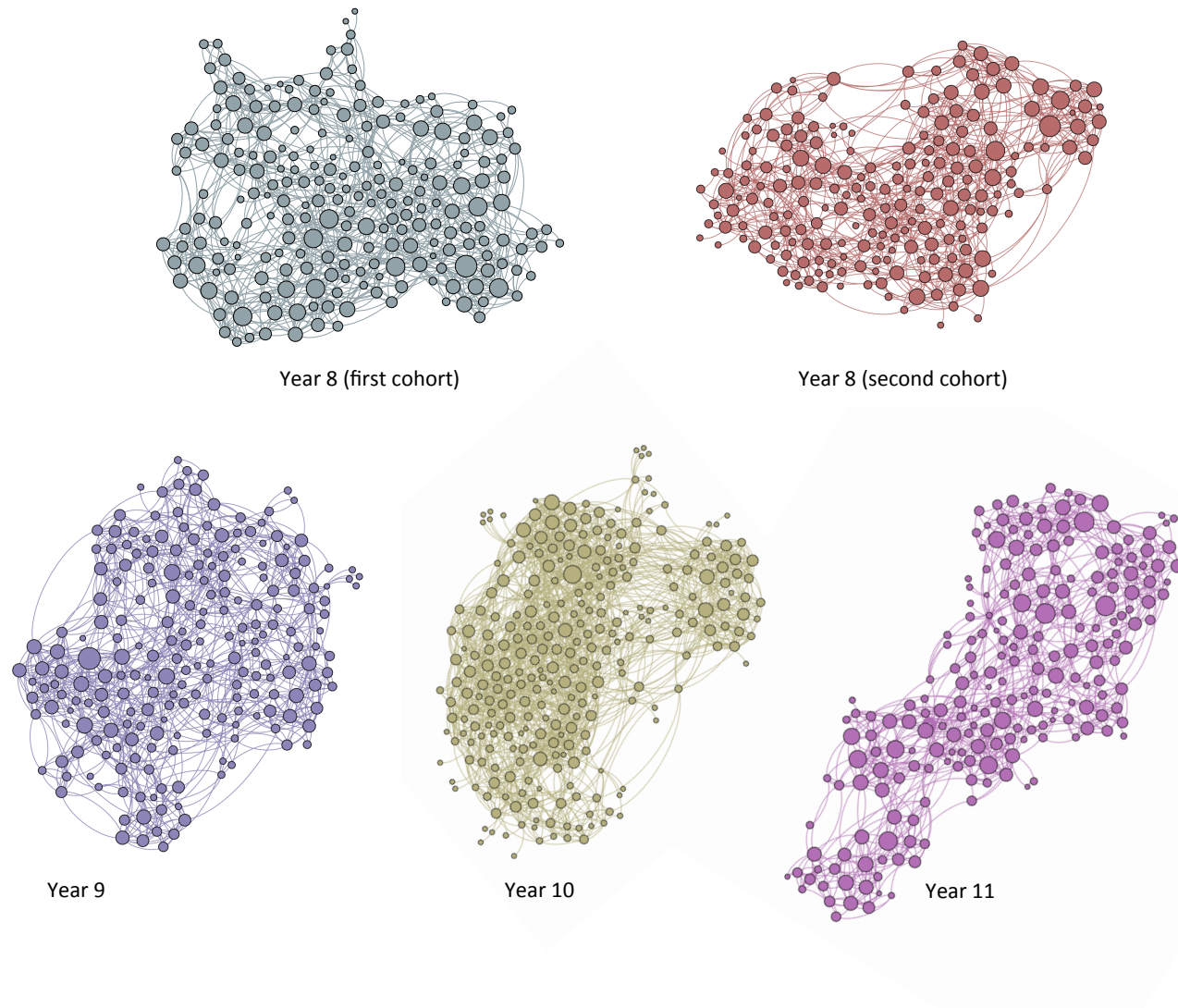
Because students could name other students who did not themselves take the survey, it was possible to calculate network scores (except out-degree) for participants who did not name any friends. This was only done for in-degree, however, because this is the measure most robust to degradations in network structure (Borgatti, Carley, & Krackhardt, 2006) and should be least influenced by an individual not taking the survey. However, students who did not respond to the survey were named substantially less, possibly because being present in the classroom when other students filled out these surveys served as a reminder cue that made being named as a friend more likely. Thus, participation in the survey is always controlled for when predicting in-degree. A total of seven separate indices of a student's popularity were calculated, then, from networks that captured as richly as possible the social world of all the students in our cohorts. As an illustration, the complete social networks for each of the five cohorts are presented in Figure 1, with each node sized relative to the in-degree of the student it represents.

In sum, this study used a variety of measures to capture two forms of overconfidence, as well as mental health outcomes, effort, achievement, and popularity across two successive school years in a large sample of high-school aged boys.

Results

In all of the analyses presented, cohort is controlled for with a dummy-coded variable to account for any differences between the classes.

Figure 1. Visualisations of networks for each of the five cohorts, with nodes sized relative to in-degree



Calculating overconfidence. The sample exhibited overconfidence on average, with the mean response to both the intelligence ($M = 72.38$, $SD = 18.21$) and sporting ability ($M = 70.29$, $SD = 25.09$) measures being significantly above the scale mid-point (50%) according to one-sample t-tests ($t(893) = 36.75$, $p < .001$ and $t(893) = 24.18$, $p < .001$, respectively).

The correlation between self-rated sporting ability and the sporting ability measure was moderate, $r(514) = .43$, ($p < .001$). Overconfidence in sporting ability was calculated by taking the standardised residual of self-ratings predicted from ability. Overconfidence in sporting ability was significantly correlated with overconfidence in intelligence, $r(324) = .34$, $p < .001$.

The correlation between self-rated intelligence and the Allwell was $.39$ ($p < .001$). The correlation between self-rated intelligence and cumulative GPA was $.51$ ($p < .001$). Further, when cumulative GPA and the Allwell were entered simultaneously as predictors of self-rated intelligence, cumulative GPA remained a strong predictor ($\beta = .45$, $p < .001$) but the Allwell did not ($\beta = .09$, $p = .045$). It is possible that some of this differential effect could be due to students' prior overconfidence in their intelligence leading to higher grades by the beginning of the survey, but it seems likely that in large part this differential relationship is due to students using their GPAs as a benchmark for assessing their own intelligence, given the high relevance of GPA to them. Because the direction of causality cannot be disentangled cross-sectionally, the conservative approach is to assume that both cumulative GPA and the Allwell reflect current student intelligence at the start of the survey. Therefore, overconfidence in intelligence was calculated by taking the standardised residual of self-ratings predicted from both cumulative GPA and the Allwell. Because the Allwell was not available for all students, intelligence overconfidence scores were available for 689 students. Sporting overconfidence scores were available for 514 students. All regression analyses control for the variables used to calculate the relevant overconfidence measure.

The Effects of Overconfidence on Mental health

Cross-sectionally, intelligence overconfidence was significantly related to better mental health outcomes on all self-report measures (see Table 1). Sporting overconfidence was related to higher self-esteem and life satisfaction, but not to lower anxiety or depression. Neither type of overconfidence predicted number of visits to the school counsellor, the only non self-report measure of mental health. Both intelligence and sporting overconfidence predicted cross-sectional reports of less loneliness at Time 1. However, neither predicted changes in loneliness over time.

Longitudinally, there were no significant effects of sporting overconfidence on change in mental health indicators (see Table 2). Intelligence overconfidence predicted significant increases in self-esteem over time, but did not predict any changes in other mental health indicators (see Table 2). The results for intelligence overconfidence are consistent with Dufner and colleagues (2012) in terms of increased self-esteem, but do not replicated their finding of decreased depression. They also differ from Robins and Beer, (2001) who found decreases in self-esteem over time.

The Effects of Overconfidence on Motivation

Cross-sectionally, overconfidence in intelligence predicted grades in the current year (see Table 3) controlling for cumulative GPA (which included those grades) and the Allwell. However, since students would have already taken most of the tests determining these grades when they responded to the Wave 1 survey, their “overconfidence” could simply reflect the knowledge that their latest grades were better than their cumulative GPA might lead one to

Table 1.

Standardized Betas and Confidence Intervals for Models Predicting Cross-sectional Mental Health Outcomes.

Outcome variable	Intelligence				
	Overconfidence	Cum GPA	Allwell	df	Adjusted R ²
Self-esteem	.23*** [.16, .30]	-.06 [-.29, .17]	-.05 [-.15, .05]	648	.06
Life Satisfaction	.09* [.02, .17]	.24 [-.01, .48]	-.14* [-.24, -.03]	634	.06
Anxiety	-.09* [-.02, -.17]	-.07 [-.16, .31]	.00 [-.10, .10]	636	.01
Depression	-.15*** [-.07, -.22]	-.44*** [-.20, -.68]	.05 [-.05, .16]	636	.05
Loneliness	-.14*** [-.22, -.07]	-.27* [-.51, -.03]	.04 [-.06, .15]	638	.05
Counsellor visits	-.02 [-.09, .05]	-.41*** [-.64, -.18]	.10 [-.01, .20]	670	.11
Sports					
	Overconfidence	Sporting ability		df	Adjusted R ²
Self-esteem	.20*** [.11, .29]	.17*** [.07, .27]		508	.05
Life Satisfaction	.11* [.02, .20]	.15** [.05, .26]		503	.02
Anxiety	-.07 [-.16, .01]	-.14** [-.25, -.04]		503	.03
Depression	-.05 [-.14, .04]	-.12* [-.02, -.22]		503	.01
Loneliness	-.11* [-.20, -.03]	.14** [-.24, .04]		504	.02
Counsellor visits	.01 [-.05, .08]	-.04 [-.11, .04]		356	.01

Note. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

Table 2.*Standardized Betas and Confidence Intervals for Models Predicting Longitudinal Mental Health Outcomes*

Outcome variable	Intelligence					Adjusted R ²
	Time 1 value	Overconfidence	Cum GPA	Allwell	df	
Self-esteem	.35*** [.26, .43]	.13** [.04, .21]	.13 [-.12, .39]	-.07 [-.18, .04]	508	.14
Life Satisfaction	.55*** [.47, .62]	.00 [-.08, .07]	-.04 [-.28, .20]	-.01 [-.11, .09]	499	.29
Anxiety	.52*** [.44, .61]	-.03 [-.12, .05]	-.06 [-.31, .19]	.09 [-.01, .20]	485	.24
Depression	.39*** [.30, .48]	-.01 [-.09, .08]	-.19 [-.46, .08]	-.01 [-.12, .11]	485	.13
Loneliness	.62*** [.55, .70]	-.04 [-.12, .03]	-.02 [-.24, .21]	-.02 [-.11, .08]	501	.35
	Sports				df	Adjusted R ²
	Time 1 value	Overconfidence	Sporting ability			
Self-esteem	.36*** [.24, .48]	-.01 [-.13, .10]	-.10 [-.24, .04]		288	.11
Life Satisfaction	.52*** [.43, .62]	-.01 [-.11, .08]	-.09 [-.21, .03]		286	.28
Anxiety	.52*** [.41, .63]	-.03 [-.14, .07]	.04 [-.09, .16]		276	.26
Depression	.38*** [.27, .49]	-.01 [-.11, .10]	.04 [-.08, .16]		276	.14
Loneliness	.60*** [.49, .71]	-.03 [-.13, .07]	-.02 [-.13, .10]		287	.31

Note. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

expect¹, and thus this relationship cannot be clearly interpreted as evidence for motivation. Even controlling for the current year Grades in addition to cumulative GPA, however, overconfidence in intelligence predicted engagement as measured by the collective self-esteem measure ($\beta = .08, p = .045$), indicating that individuals who are overconfident in their intelligence perceived the school as more central to their identity. Intelligence overconfidence did not predict increased engagement with co-curricular activities. Nor was intelligence overconfidence associated with greater teacher ratings of effort (see Table 3). In the sporting domain, although hours of sporting practice were not measured at Time 1, overconfidence did predict the number of sport-related co-curricular activities students engaged in at Time 1, as well as their collective self-esteem, which in this case could potentially be interpreted as indexing engagement with their sporting teams within the school (see Table 3).

Longitudinally, overconfidence in intelligence was not related to increases in teacher-rated effort nor to better grades at the second time-point, controlling for grades at the first time-point (see Table 4). Intelligence overconfidence was also not related to increases in collective self-esteem or co-curricular engagement. Overconfidence in sport, however, predicted the number of hours students reported practicing at Time 2 (see Table 4), and continued to do so after controlling for sporting co-curricular activities at Time 1. Moreover, sporting overconfidence at Time 1 predicted increased sporting ability at Time 2, and this relationship was fully mediated by hours practiced ($IE = .05, p = .041, DE = .046, p = .399$). Thus, it seems that students who were overconfident in their sporting ability practiced more over the following year, and because of this greater practice they actually improved in their sporting ability.

¹ Because of this, current year GPA was controlled for in addition to cumulative GPA and the Allwell in all other analyses in this Study that used intelligence overconfidence as a predictor

Table 3.

Standardized Betas and Confidence Intervals for Models Predicting Cross-sectional Motivational Outcomes

Outcome variable	Intelligence				Adjusted R ²
	Overconfidence	Cum GPA	Allwell	df	
Current Year Grades	.03* [.00, .05]	.96*** [.93, 1.00]	.03 [-.01, .06]	671	.89
Cocurriculars	.05 [-.01, .11]	.29** [.10, .47]	-.13** [-.21, -.05]	670	.09
Class effort	.02 [-.02, .06]	.24*** [.12, .36]	-.05* [-.11, .00]	670	.76
Collective self-esteem	.08* [.00, .16]	.31* [.05, .57]	-.16** [-.27, -.05]	637	.02
	Sports			df	Adjusted R ²
	Overconfidence	Sporting ability			
Cocurriculars	.30*** [.22, .37]	.39*** [.31, .48]		509	.21
Sporting cocurriculars	.19*** [.13, .25]	.17*** [.10, .25]		509	.11
Collective self-esteem	.12** [.04, .20]	-.03 [-.12, .06]		503	.01

Note. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

Table 4.

Standardized Betas and Confidence Intervals for Models Predicting Longitudinal Motivational Outcomes

Outcome variable	Intelligence					Adjusted R ²
	Time 1 value	Overconfidence	Cum GPA	Allwell	df	
GPA	.59*** [.49, .68]	.00 [-.03, .03]	.28*** [.18, .38]	.08*** [.03, .12]	665	.83
Class effort	.49*** [.40, .58]	-.02 [-.06, .03]	.16* [.01, .31]	.00 [-.06, .07]	664	.64
Collective self-esteem	.47*** [.40, .54]	-.03 [-.11, .05]	.15 [-.09, .40]	-.02 [-.13, .08]	496	.26
	Sports				df	Adjusted R ²
	Time 1 value	Overconfidence	Sporting ability			
Sporting ability	.90*** [.78, 1.02]	.11* [.01, .21]			167	.57
Sporting cocurriculars	.26*** [.19, .33]	.05 [-.01, .12]	.01 [-.07, .09]		508	.45
Sporting practice	-	.40*** [.30, .50]	.36*** [.24, .47]		292	.24
Collective self-esteem	.31*** [.20, .42]	-.02 [-.13, .08]	.01 [-.12, .13]		283	.09

Note. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

The Effects of Overconfidence on Social Outcomes

Intelligence overconfidence did not predict any network outcomes at Time 1 (see Table 5), and sporting overconfidence predicted only one: closeness. Longitudinally, sporting overconfidence predicted increases in in-degree (see Table 6), degree, number of triangles, and Page-Rank, but not higher percentage of mutual ties. There was no change in out-degree or closeness. In contrast, intelligence overconfidence had no longitudinal effects (see Table 6).

It does not appear that the social benefits created by sporting overconfidence are the result of the increase in sporting engagement or ability that it led to. The data showed no indication that an increase in sporting ability over time mediated the effects of sporting overconfidence on in-degree (see Appendix A, Table 13). Rather, sporting overconfidence seems to have resulted in increased performance and better social outcomes, largely independent of one another.

Despite the fact that these data were collected at an all boys' school, the evidence suggests that the difference in social outcomes across intelligence and sporting overconfidence is not a function of the social value placed on academics versus sport. When Time 1 Allwell and sporting ability were allowed to predict Time 1 in-degree simultaneously, both were significant predictors ($\beta = .10, p = .008$ and $\beta = .20, p < .001$, respectively), and the same was true when sporting ability was entered simultaneously with GPA ($\beta = .23, p < .001$ and $\beta = .14, p < .001$, respectively). It is worth noting, however, that the Allwell did not predict in-degree at Time 1 after controlling for GPA ($\beta = -.06, p = .217$), and so intelligence in the absence of grades did not seem to be socially valued.

Table 5.

Standardized Betas and Confidence Intervals for Models Predicting Cross-sectional Social Outcomes

Outcome variable	Intelligence				Adjusted R ²
	Overconfidence	Cum GPA	Allwell	df	
In-degree	-.03 [-.1, .04]	.18 [-.04, .40]	-.05 [-.15, .05]	664	.18
Out-degree	.04 [-.03, .11]	-.01 [-.23, .21]	-.01 [-.10, .09]	609	.23
Degree	-.02 [-.09, .05]	.09 [-.12, .31]	-.04 [-.14, .05]	609	.29
Number of triangles	-.04 [-.12, .03]	.06 [-.16, .29]	-.06 [-.15, .04]	609	.22
Closeness	.04 [-.01, .10]	.06 [-.11, .22]	-.06 [-.13, .01]	609	.59
Page-Rank	-.08 [-.16, .01]	.24 [-.02, .49]	-.09 [-.20, .03]	609	.03
Percent Mutual	-.03 [-.12, .05]	.22 [-.04, .47]	-.03 [-.14, .09]	605	.01
	Sports			df	Adjusted R ²
	Overconfidence	Sporting ability			
In-degree	.01 [-.06, .08]	.24*** [.16, .33]		504	.08
Out-degree	.07 [-.02, .16]	.14** [.04, .24]		457	.12
Degree	.04 [-.04, .11]	.23*** [.14, .31]		457	.13
Number of triangles	.00 [-.06, .06]	.16*** [.09, .23]		457	.11
Closeness	.08** [.02, .14]	.16*** [.10, .23]		457	.35
Page-Rank	.01 [-.08, .10]	.28*** [.18, .38]		457	.05
Percent Mutual	-.09 [-.18, .01]	.19*** [.08, .30]		455	.02

Note. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

Table 6.*Standardized Betas and Confidence Intervals for Models Predicting Longitudinal Social Outcomes*

Outcome variable	Intelligence					Adjusted R ²
	Time 1 value	Overconfidence	Cum GPA	Allwell	df	
In-degree	.64*** [.57, .70]	-.02 [-.08, .04]	-.05 [-.23, .13]	.10* [.02, .18]	646	.50
Out-degree	.40*** [.30, .50]	.09 [-.01, .18]	.09 [-.19, .37]	.06 [-.06, .18]	442	.15
Degree	.68*** [.60, .75]	.04 [-.04, .11]	-.01 [-.24, .21]	.10* [.01, .20]	442	.47
Number of triangles	.74*** [.67, .80]	-.01 [-.08, .06]	-.10 [-.31, .10]	.11* [.02, .19]	442	.57
Closeness	.62*** [.53, .71]	.03 [-.04, .09]	.31** [.12, .50]	.04 [-.04, .12]	442	.64
Page-Rank	.52*** [.44, .60]	.03 [-.06, .11]	-.13 [-.39, .13]	.16** [.05, .27]	442	.32
Percent Mutual	.36*** [.27, .44]	-.01 [-.10, .09]	-.14 [-.42, .13]	.05 [-.06, .17]	436	.17
	Sports				df	Adjusted R ²
	Time 1 value	Overconfidence	Sporting ability			
In-degree	.46*** [.38, .55]	.10* [.02, .19]	.07* [.00, .14]		475	.27
Out-degree	.15* [.02, .28]	.12* [.01, .23]	-.14 [-.43, .14]		320	.02
Degree	.57*** [.46, .68]	.08 [-.03, .19]	.11* [.02, .20]		295	.30
Number of triangles	.47*** [.34, .61]	.10 [-.01, .20]	.13** [.05, .22]		295	.20
Closeness	.49*** [.38, .61]	.10* [.01, .19]	.03 [-.04, .10]		295	.25
Page-Rank	.47*** [.37, .58]	.10 [-.03, .22]	.10* [.00, .20]		295	.25
Percent Mutual	.30*** [.20, .41]	.13* [.00, .26]	.10 [-.01, .20]		293	.12

Note. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

Discussion

This study provides the first longitudinal test of all three major adaptive hypotheses of overconfidence in a single sample, across two domains of overconfidence. The results are somewhat mixed, but one hypothesis that emphatically does *not* seem to be supported is that overconfidence is a maladaptive response that leads to ruin in the long run. In every outcome tested, whether intrapsychic, performance-based, or social, the effects of overconfidence were either positive or neutral. Longitudinally, overconfidence predicted no worsening of mental health outcomes, and in fact intelligence overconfidence predicted increased self-esteem. While overconfidence in intelligence had no effect on performance or social outcomes over time, overconfidence in sporting ability predicted more effort in sports, increased sporting ability as a result of this, and a panoply of positive social outcomes as measured by student social networks.

A key take-home point is the importance of investigating overconfidence across multiple domains. The results from this study replicated Robins and Beer (2001) in the finding that overconfidence in intelligence did *not* predict increased grades. Had the analyses ended there, however, the story would have been incomplete. In contrast to intelligence overconfidence, sporting overconfidence led to increased effort, which led to improved performance. Thus, the motivational hypothesis was supported in one domain but not the other. Unfortunately, it is difficult to know why only one type of overconfidence had an effect, particularly given that two of the three previous studies have shown that overconfidence in intelligence does increase grades (Blanton et al., 1999; Wright, 2000).

One possible explanation could be measurement differences. Both studies that have found effects of overconfidence on improved grades have measured overconfidence in academic ability specifically (Blanton et al., 1999; Wright, 2000), whereas this study measured overconfidence in intelligence. It could be that being overconfident in your ability

to succeed in academics drives you to work harder in class in a manner that being overconfident in your intelligence does not. Children praised on their intelligence are less likely to believe that intelligence can be improved and respond worse to failure (Mueller & Dweck, 1998), so it is possible that inflated views of one's own intelligence have similar effects. It would be telling to compare these two measures of overconfidence directly in future work.

Alternatively, individuals who know they are more intelligent than their current grades suggest might respond to a self-rated academic ability scale more positively than would be predicted from their current academic performance, and then go on to do better. Individuals are known to use domain-general ability when rating their performance on more specific sub-domains (Ehrlinger & Dunning, 2003), so it seems likely that self-perceptions of intelligence would influence ratings of academic ability. This suggests that prior studies might have been measuring reverse causality. In tangential support for this possibility, if the data from the current study are re-analysed using only a subset of 'core' classes at Time 1 and Time 2 (as was done in the study by Blanton and colleagues, 1999), overconfidence in intelligence significantly predicts improved grades over time (see Appendix A, Table 14). This may be because the knowledge students have about their general academic performance is mismeasured as overconfidence.

Another possible measurement issue is that the previously observed effects of intelligence overconfidence may have been inflated by 'perceiver effects' that are controlled for with the percentile scales used in this study. Previously reported benefits of intelligence overconfidence might have been due to a general positivity effect conflated with overconfidence (Kwan et al., 2004). Because this study showed that sporting overconfidence was associated with benefits even using this percentile measure, it is possible that sporting and not intelligence overconfidence is genuinely performance-enhancing. In the absence of

other research testing the effects of sporting overconfidence, however, this result should be interpreted cautiously.

If it is true that intelligence overconfidence has less of an effect on performance than sporting overconfidence, why might this be? One possibility is that academic performance is less influenced by effort than athletic performance. While the results did not show effects of intelligence overconfidence on effort, only teachers' ratings of effort were measured, and these closely mirrored the grades themselves. Perhaps other indicators of effort would have shown an effect. The study did find cross-sectional effects of intelligence overconfidence on self-reported engagement with the school, but it did not predict increases over time. Nor did school engagement itself predict increased academic performance over time, for that matter.

Another possibility is that there is more variance in the effort school-aged boys invest in sport than in academics. Students who are truly unmotivated can opt out almost entirely from physical activity, while all school-aged children must spend most of their days in a learning-focused environment, perhaps minimizing the chances for overconfidence to induce differential effort. To the extent that this could be tested in the data, however, engagement with sporting co-curriculars did not seem to explain the effects of overconfidence on practice or enhanced ability, so this possibility remains speculative.

Cross-sectionally, the most widely reported mental health benefits of overconfidence were replicated, however there was little causal effect over time; intelligence overconfidence only predicted increased self-esteem. This is in direct contrast to Robins and Beer (2001), who found that intelligence overconfidence led to a decrease in self-esteem, but is in accord with Dufner and colleagues (2012), who also found that intelligence overconfidence increased self-esteem. Nonetheless, this study did not replicate the effects of reduced depression reported by Dufner and colleagues (2012).

One limitation of these data is that it was not possible to capture ratings of sporting ability, intelligence, and confidence from peers. Thus, it is impossible to know if the difference in social outcomes between sporting and intelligence overconfidence stems from a differential ability to convey the trait in question to peers, or a different outcome of doing so. It is possible that overconfident individuals in each domain projected increased levels of that trait, but that something else differed across categories. One possibility is that the friendships created by people who were overconfident in their intelligence were not the kinds that would lead to increased network popularity. Alternatively, perhaps only overconfidence in sporting ability led individuals to be more generally confident in a way that would help to create friendships. The Allwell was the weakest predictor of cross-sectional social outcomes, indicating that intelligence for its own sake may not have been valued highly in this sample. If the students were aware of this, overconfidence in their intelligence may not have led them to be generally more confident to the same degree as would sports. In Chapter 3, I pursue the question of exactly how overconfidence improves popularity, in a different social domain.

Chapter 3: The Role of Overconfidence in Romantic Competition

Introduction

One of the key findings from Chapter 2 was evidence that overconfidence can cause lasting social benefits over time that are strong enough to influence people's popularity within their social network. That study also represents some of the first evidence that overconfidence has social benefits beyond its effect on increasing perceptions of competence in task-oriented groups. However, the data did not allow an assessment of the mechanism whereby overconfidence led to enhanced social performance. Were individuals overconfident in their sporting ability more popular because they better conveyed a general sense of confidence in themselves, or was it specifically because they convinced others of their enhanced sporting ability? The fact that actual sporting ability did not predict increased popularity over time suggests that the former option might be the case. That is, perhaps individuals who were overconfident in their sporting ability, presumably a socially valued skill, displayed increased general confidence, rather than simply increased confidence in their physical prowess.

One of the aims of the research presented in Chapter 3 was to expand the findings of Chapter 2 by investigating whether the social benefits of overconfidence are due to perceptions of increased confidence. Previous work has found that in task-oriented domains the status benefits of overconfidence seem to emerge because individuals convey increased competence to others. It is hypothesised here, however, that overconfidence can increase popularity directly via increased perceptions of confidence. After all, confidence signals not just ability in a specific domain, but a positive general self-assessment that should be relevant to social judgements in many domains.

A second aim of the research presented in this chapter is to extend the finding that overconfidence can improve individuals' popularity with same-sex friends by testing whether

overconfidence might have benefits on popularity as a romantic partner. Choosing and attracting the right romantic partner are two of the most critical challenges in human life. Not only are good relationships a key to happiness (Zimmermann & Easterlin, 2006), our romantic partners also influence the survival and success of any children we might have, through the care they provide and the heritable qualities they pass on. Obviously, popularity as a romantic partner is a key adaptive social outcome. However, no work to date has tested the effects of overconfidence on romantic success.²

Because mate choice is so important, the effects of overconfidence in this domain may not mirror the effects of overconfidence on social success in other domains. The research reviewed so far, and the findings of Chapter 2, suggest that overconfidence as an interpersonal strategy may help people sell themselves to others - and there is no more important sales pitch than the one we make when trying to attract a romantic partner. Because of their evolutionary importance, however, potential romantic partners are likely to receive more and different scrutiny than potential colleagues, bosses, or even friends – making failure more likely if overconfidence is unconvincing. Nevertheless, if overconfident people come across as more than they are despite this scrutiny, they would gain a substantial adaptive advantage.

It is hypothesised that overconfident individuals will benefit romantically from their overconfidence due to their increased displays of confidence. As is the case for teammates and friends, many of the traits that people value in a partner, such as intelligence, kindness, and competence (Buss & Barnes, 1986), are not directly visible and thus must be inferred from relevant behaviours. And, although different traits have their own behavioural signatures, the confidence heuristic would suggest that potential partners will assume a

² Two studies have found relationships between self-report measures such as the BIDR and number of reported sexual partners, but do not speak to the effects of overconfidence for the reasons discussed in Chapter 1 (Koban & Ohler, 2016; Lynn, Pipitone, & Keenan, 2014).

confident individual possesses desirable traits to a greater degree than a non-confident individual. Thus, to the extent that overconfident individuals are perceived as more confident, they should be more romantically desirable. The goal of the studies presented in this Chapter was to test whether the benefits of overconfidence to popularity are primarily due to increased perceptions of confidence, and to extend previous research by testing whether these effects would help overconfident people succeed in their romantic endeavours.

Study 1

Study 1 investigated whether overconfident individuals are perceived as more confident by observers, in turn leading them to be judged as more romantically desirable. To test this possibility, one group of participants completed a measure of overconfidence and then wrote dating profiles. A second group of participants rated these profiles for their confidence and desirability as romantic partners.

Method

Participants

Authors were recruited online through Amazon's Mechanical Turk (Mturk) for a study that involved writing a short dating profile. Authors were heterosexual North Americans (N = 196; 53.8% female, 59.5% aged 25 or older).³ Authors received \$1 for their participation.

Raters were North Americans (N = 63; 58.7% female, 65.1% aged 25 or older) recruited through Mturk to rate profiles that matched their sexual orientation (53 participants identified as heterosexual, 4 as homosexual, and 6 as bisexual).⁴ Bisexual raters were assigned opposite gender profiles. Raters received \$.50 for their participation.

³ Age was measured categorically in Studies 1 and 2.

⁴ Results were unchanged by excluding non-heterosexual raters in Studies 1 and 2, and so they were included in all analyses.

Procedure and Measures

Overconfidence. To measure overconfidence, authors completed the Over-Claiming Questionnaire (OCQ; Paulhus et al., 2003). This questionnaire measures overconfidence through the tendency to *over-claim*, or claim knowledge that one does not have. The OCQ consists of 150 items. Participants are told the items are being pre-rated for relevance in a future study, and asked to rate how familiar they are with each item, on a scale ranging from 0 (*not familiar at all*) to 4 (*extremely familiar*). One in every five items is a non-existent foil (e.g., ‘ultra-lipids’, ‘sentence stigma’) and thus the extent to which participants rate familiarity with these bogus items reflects a tendency to over-claim. Overconfidence (operationalised here as over-claiming) was measured with a statistical index known as *c*, or response bias, calculated as per Paulhus and colleagues (2003). This index roughly corresponds to the mean of the hit and false alarm rates⁵ (Stanislaw & Todorov, 1999). Response bias represents how readily participants claim familiarity with items, regardless of their existence, and it correlates with other measures of overconfidence, such as overly positive self-ratings of IQ (Paulhus et al., 2003).

Accuracy. Because cultural knowledge varies, accuracy on the OCQ was calculated to control for participants’ ability to distinguish existing from bogus cultural items. Accuracy was calculated by subtracting the standardised false alarm rate from the standardised hit rate.

Dating profile measure. After completing the OCQ, authors prepared dating profiles. Authors were asked to imagine themselves as romantically unattached and preparing a profile to attract members of the opposite sex, and to write a short dating profile that would give a prospective mate a better idea about them (see Simpson, Gangestad, Christensen, & Leck, 1999). The profiles were collected and filtered to remove those that contained less than 30 words, explicitly mentioned being in a current relationship, or did not appear to be

⁵ OCQ bias and accuracy are calculated using a score of 1, “slightly familiar”, as the cutoff for a hit, then 2, 3, and 4. These scores are then averaged to get the overall bias and accuracy indices.

genuine efforts to construct a dating profile (e.g., profiles plagiarised from online sources). Twenty-three profiles were removed in this fashion (leaving a total of 173 usable profiles). All original wording and grammar were retained in the remaining profiles, which were then randomly assigned to raters who were sexually oriented toward the author's gender.

Dating profile ratings. Participants in the rater group ($N = 63$) were told that they would be rating paragraphs intended as brief self-descriptions, and were asked to use their intuition to make judgments about the authors. Raters were randomly assigned between 28 and 32 profiles to rate on two single-item measures: how *confident* the author seemed and how *desirable* as a dating partner he or she seemed.⁶ Ratings were provided on a 4-point scale, from 1 (*not at all*) to 4 (*very*). The order of presentation of profiles was randomised.

Results

For each author who wrote a dating profile, the scores that they were given by raters (each profile was assessed by an average of 11 raters) on each trait were averaged to create mean scores of how confident they seemed and how desirable raters found them. Means, standard deviations, and zero-order correlations for the variables of interest are presented in Table 7 (with authors as the unit of analysis).⁷ The primary hypotheses were tested with mediation using the *lavaan* package in R (version 3.1.0, as are all following analyses). As predicted, authors' overconfidence directly predicted how confident raters perceived them to be ($DE = .26, p < .001$), and indirectly predicted how desirable raters found them through confidence as a mediator ($IE = .14, p = .001$). There was no direct effect of authors'

⁶ Although less central to hypotheses, raters also judged how creative, intelligent, humorous, and high in social status each author seemed. Confirmatory factor analyses indicated that when these variables were combined with confidence they did not form a single *positivity* factor. Rather, confidence was conceptually distinct from these other positive traits, and further analyses indicated that confidence was the only consistent mediator of the positive effects of overconfidence on desirability. For more information on analyses with these variables, please see Appendix B.

⁷ All mediation and SEM analyses in Studies 1 through 4 are based on linear regression using averaged ratings. Averaged ratings are also the basis of all correlation tables. Mixed-effects (multilevel) models that accounted for the nested data structure (each rater judging multiple authors, each author rated by multiple raters) did not show any differences from the reported results.

Table 7.*Means, standard deviations, and zero-order inter-correlations for Study 1.*

	M (SD)	1	2	3	4	5	6	7	8	9	10
1. OCQ Overconfidence	0.00 (0.82)	-									
2. Confidence	2.90 (0.41)	.26***	-								
3. Desirability	2.31 (0.51)	.14	.53***	-							
4. Social Status	2.24 (0.47)	.26***	.62***	.66***	-						
5. Intelligence	2.61 (0.49)	.22**	.47***	.70***	.73***	-					
6. Creativity	2.52 (0.51)	.18*	.56***	.57***	.50***	.62***	-				
7. Humour	2.12 (0.47)	.05	.41***	.48***	.33***	.25**	.47***	-			
8. Gender (Male)	1.46 (0.50)	.09	-.02	-.36***	-.29***	-.10	-.01	-.36***	-		
9. Word Length	107.87 (61.13)	.17*	.41***	.26***	.37***	.33***	.31***	.24**	-.03	-	
10. OCQ Accuracy	0.00 (0.82)	.02	.27***	.38***	.29***	.45***	.43***	.19*	.05	.11	-

Note. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

overconfidence on how desirable they were seen in the presence of the mediated pathway ($DE = .00, p = .951$). Despite the significant mediated effect, there was also no zero-order relationship between overconfidence and desirability (see Table 7). Additionally, gender of the author did not moderate the effects of overconfidence on confidence or desirability, or the effects of confidence on desirability.⁸

Discussion

Consistent with predictions, overconfidence manifested itself in greater projected confidence. Despite the divergence between the two measures, people who claimed familiarity with things that did not exist were also perceived as more confident in their dating profiles. As confidence was also predictably found to be highly desirable in a romantic partner, this provides initial support for the idea that the social benefits of overconfidence could be due to increased perceptions of confidence. Overconfidence also showed the expected indirect association with desirability; to the extent that overconfident individuals were perceived as more confident, they were also perceived as more desirable.

Previous research has shown that self-confidence tends to be rated as more important by women than men (Buunk et al., 2002). Consequently, it might seem surprising that confidence was not more strongly associated with desirability for male authors in this sample. However, explanations for this gender difference hinge on men judging women on the basis of visible indicators such as physical attractiveness, while women rely more heavily on confidence as a proxy for internal traits that are valued in men, such as ambition and status. Reliance on written dating profiles removes appearance from the equation, which apparently led raters of both genders to rely equally on confidence as an indicator of mate value.

⁸ All mediation and SEM analyses in Studies 1 through 4 are based on linear regression using averaged ratings. Averaged ratings are also the basis of all correlation tables. Mixed-effects (multilevel) models that accounted for the nested data structure (each rater judging multiple authors, each author rated by multiple raters) did not show any differences from the reported results.

Despite the significant indirect effect of overconfidence on desirability, the results revealed no overall association between overconfidence and romantic desirability. There are two possible explanations for this lack of a direct association. First, the relationship between overconfidence and desirability might be small enough that only the indirect association emerged as significant, due to greater power to detect mediated than direct relationships (Kenny & Judd, 2013; Shrout & Bolger, 2002). Second, overconfidence might simultaneously diminish desirability in an unmeasured manner that suppressed the positive effect of confidence.

According to this second explanation, overconfidence may carry social costs as well as benefits. While often beneficial, portrayals of confidence are not always perceived positively, as individuals who exude confidence without sufficient social skill can seem brazen, self-promoting, or arrogant (R. E. Johnson et al., 2010). Thus, overconfident individuals may inadvertently project negative attributes such as arrogance, especially under the watchful eyes of potential mates. Given that people react negatively to arrogance in romantic partners (Gangestad, Garver-Apgar, Simpson, & Cousins, 2007), such an increase in perceived arrogance might have suppressed the otherwise positive effects of overconfidence on romantic desirability. A second study was conducted to test this possibility.

Study 2

Study 2 was a direct replication of Study 1, with two exceptions. First, the sample size was increased to facilitate the detection of a possible small direct effect of overconfidence on romantic desirability. Second, each profile was also rated for arrogance.

Method

Participants

Authors (N = 466, 64.4% female, 62.6% aged 25 or older) and raters (N = 333, 36% female, 64.9% aged 25 or older; 306 heterosexual, 5 homosexual, and 22 bisexual) were recruited through Mturk as in Study 1. Each rater evaluated only 15 profiles, but as there were more raters per profile than in Study 1, each profile was still rated an average of 11 times.

Procedure and Measures

Authors completed the same measures as in Study 1. Twenty-eight profiles were removed using the exclusion criteria from Study 1, leaving 438 total profiles. In addition to the items in Study 1, raters were asked to judge, on the same scale, the extent to which each profile was arrogant (see Appendix B for a profile rated high in confidence but not arrogance and a profile rated high in confidence and arrogance).

Results

Means, standard deviations, and zero-order correlations for Study 2 are reported in Table 8. The primary hypotheses were tested with structural equation modelling using the *lavaan* package in R (see Figure 2)⁹. Because I expected the association between overconfidence and desirability to be mediated by confidence and arrogance, the direct link from overconfidence to desirability was omitted. All items were entered as observed variables, with error terms for arrogance and confidence allowed to covary.

⁹ As displayed, all SEM analyses were conducted without direct paths from overconfidence to ultimate DVs, as these paths were non-significant and did not alter results (see additional analyses in Appendix B).

Table 8.*Means, standard deviations, and zero-order inter-correlations for Study 2.*

	M (SD)	1	2	3	4	5	6	7	8	9	10	11
1. OCQ Overconfidence	0.00 (0.77)	-										
2. Confidence	2.71 (0.38)	.11*	-									
3. Arrogance	1.72 (0.44)	.17***	.49***	-								
4. Desirability	2.21 (0.42)	-.02	.26***	-.31***	-							
5. Social Status	1.98 (0.39)	.11*	.45***	.22***	.42***	-						
6. Intelligence	2.52 (0.47)	.07	.34***	-.05	.57***	.48***	-					
7. Creativity	2.38 (0.50)	.03	.27***	-.04	.46***	.21***	.50***	-				
8. Humour	2.02 (0.40)	.01	.21***	-.03	.42***	.13**	.21***	.40***	-			
9. Gender (Male)	1.36 (0.48)	.12*	-.01	.09*	-.30***	-.18***	-.04	-.08	-.17***	-		
10. Word Length	120.67 (68.86)	.02	.22***	.28***	-.01	.11*	.17***	.13**	.13**	-.04	-	
11. OCQ Accuracy	0.00 (0.90)	.04	.14**	.03	.12**	.16**	.28***	.21***	.14**	-.04	.17***	-

Note. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

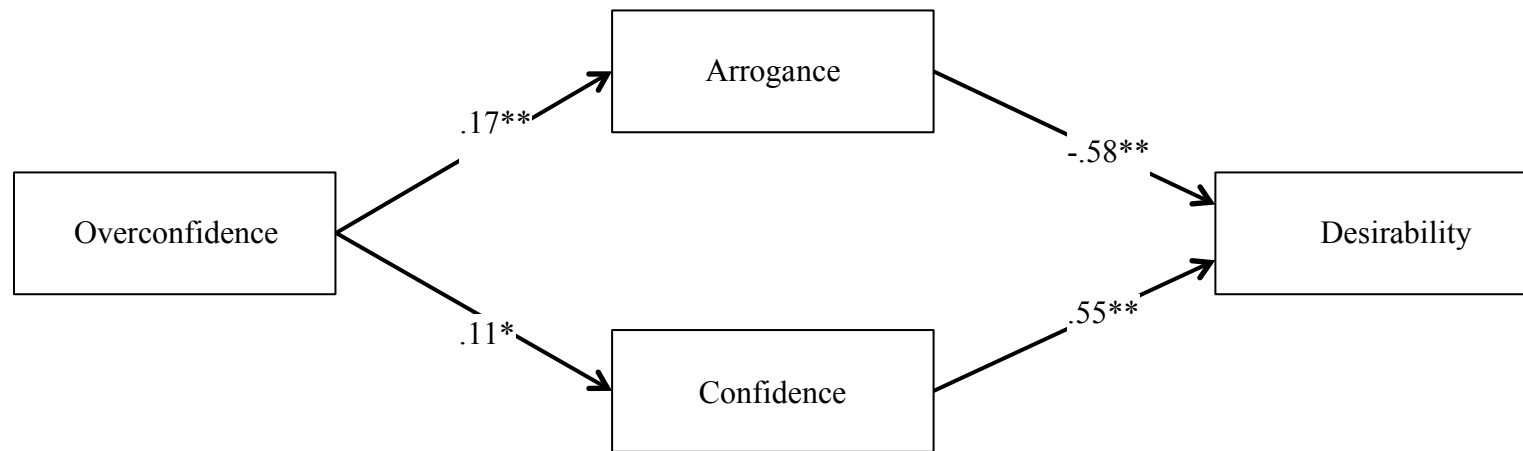


Figure 2. Study 2: Structural equation model of the effects of authors' overconfidence on desirability with confidence and arrogance as mediating variables. Relationships between the observed variables are shown.

* $p \leq .05$, ** $p \leq .01$; $N=438$.

The model provided a good fit to the data, $\chi^2 (1, N = 438) = 0.11, p = .742, \chi^2/df = 0.11$; CFI = 1.00; RMSEA = .000; SRMR = .003. As expected, profile authors' overconfidence was associated with being perceived as arrogant ($DE = .17, p < .001$) and confident ($DE = .11, p = .018$). The extent to which authors were seen as confident was positively associated with the extent to which they were seen as desirable ($DE = .55, p < .001$), while arrogance was negatively associated with desirability ($DE = -.58, p < .001$). As in Study 1, overconfidence had a positive indirect association with desirability, mediated through confidence ($IE = .06, p = .020$). Consistent with the suppressor hypothesis, overconfidence also had a negative indirect association with desirability, mediated through arrogance ($IE = -.10, p < .001$). Due to the countervailing influence of these two effects, overconfidence had a null total indirect association with desirability ($TE = -.04, p = .181$).

Discussion

The results of Study 2 provide an explanation for the lack of a direct association between overconfidence and romantic desirability. Overconfident participants wrote profiles that were seen as more confident *and* more arrogant, resulting in no overall effect on desirability. These findings explain the results of Study 1, but they are inconsistent with the hypothesis that overconfidence provides an overall benefit to romantic attraction. However, these findings do suggest an additional path by which overconfidence may facilitate mating: it might help people ward off same sex competitors (via displays of confidence *and* arrogance).

Although studies of human mating typically focus on mate choice as the critical determinant of romantic success, choice is only one aspect of acquiring a mate. Competition among members of the same sex also plays a significant role in romantic success (see Puts, 2010, for a review). By driving rivals away from potential mates, people can reduce the pool of would-be suitors and thereby increase their own chance of securing a mate. In this way,

traits that successfully eliminate competitors can have net mating benefits even if they are neutral or even detrimental in the mate-attraction stage. The biological literature is replete with examples of traits that facilitate intra-sexual competition and have a net mating benefit despite being detrimental to desirability or success as a mating partner (R. S. Wilson et al., 2010; Wong & Candolin, 2005).

The results of Study 2 suggest that overconfidence may be just such a trait. Arrogant individuals are often seen as off-putting (R. E. Johnson et al., 2010), so arrogance may be beneficial in mate competition by making it seem more difficult or unpleasant to compete with overconfident individuals. Confidence should also make the prospect of out-competing an individual seem more difficult. Thus, overconfidence, and the resulting displays of confidence and arrogance, may narrow the pool of competitors for the attention of the opposite sex. Study 3 was designed to test this possibility

Study 3

In Study 3 a new hypothetical dating scenario was set up in which a new pool of participants had the opportunity to compete with the authors of dating profiles from Study 2 for the attention of a potential mate. It was hypothesised that overconfident individuals from Study 2 would be perceived as difficult and unpleasant to compete with, due to their previously rated confidence and arrogance, and that this would lead competitors in Study 3 to avoid competing with them.

Method

Participants

Competitors were heterosexual North American participants (N = 556; 46.1% female, M = 31.47 years) who were recruited through Mturk to take part in hypothetical competition against authors of the same gender. These participants received \$.80 for their participation.

Competition task

Competitors were asked to imagine that they had joined a small online dating website, and to increase their investment in the scenario they first completed the same profile-writing task as authors in previous studies (although these profiles were not rated). The competitors were then asked to imagine that they were participating in a singles' mixer organised by the dating site and that, having read the profiles of everyone in attendance, they were only interested in one individual. Unfortunately, they arrived at the mixer to find the focus of their desire in conversation with a potential rival (of the same sex as the participant). Figure 3 shows the visual depiction of this scenario provided to participants. A friend of the object of their desire was seated at the table (to attenuate the awkwardness of interrupting an existing dyadic interaction should they attempt to sit at that table), and two less attractive opposite-sex individuals were seated un-partnered at the table to the left. Thus, the right table offered potential romantic access to the desired individual, but necessitated competing for his or her attention, while the left table offered less potential reward but involved no competition.

Competitors read five randomly chosen dating profiles from Study 2 and were told that they were competing against the author of each profile. For each profile, competitors were asked, "how pleasant do you think it would be to sit at the table (with the author)," on a five-point scale from 1=*very unpleasant* to 5=*very pleasant*, "how easy do you think it would be to deal with (the author)," from 1=*very difficult* to 5=*very easy*, and "which table would you choose to sit at," with a binary left-right decision.

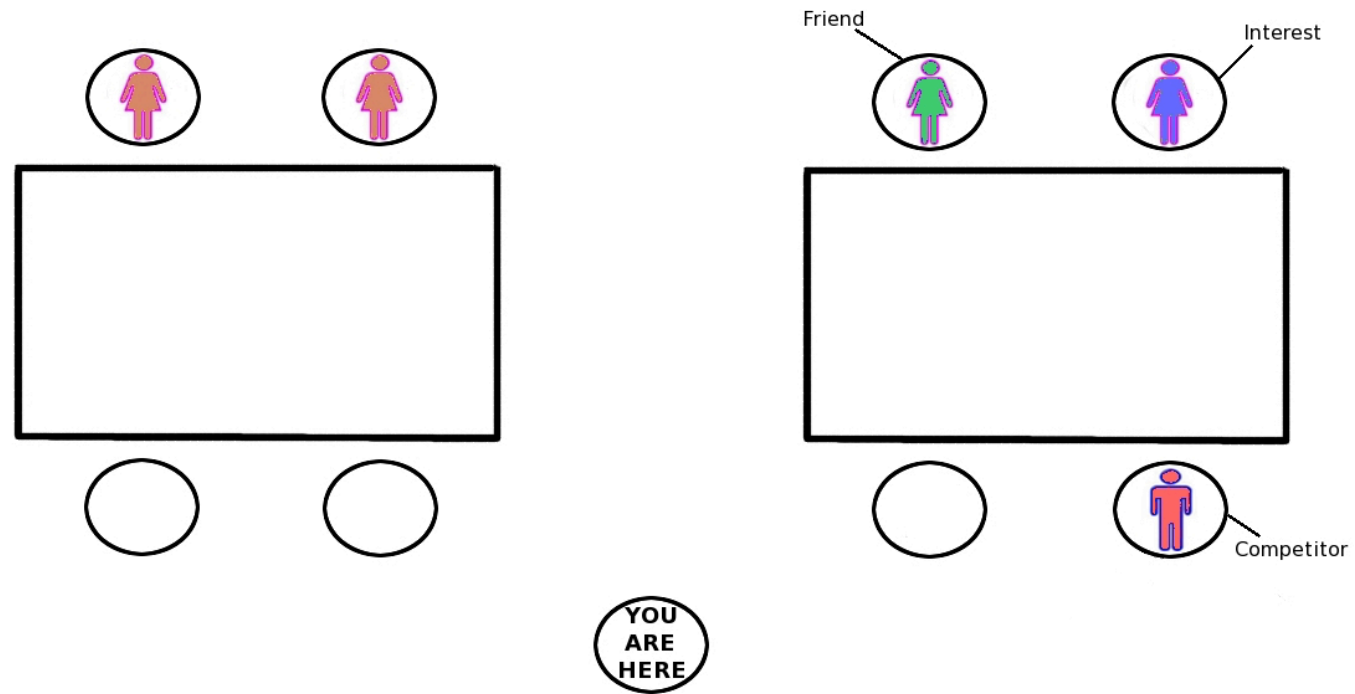


Figure 3. Study 3: Diagram presented to competitors to represent dating competition scenario.

Note. Individuals at the left table were labelled “less interesting” in text.

Results

Each author from Study 2 ($N = 438$) had their profile assessed by an average of 6 competitors. Scores on *pleasant* and *easy to deal with* were reversed to give mean scores of how *unpleasant* and *difficult to deal with* each author was found by competitors. Table choice was coded, for each author, as the percentage of competitors who chose to compete with them by sitting at their table.¹⁰ Ratings of confidence and arrogance were taken from Study 2. Means, standard deviations, and zero-order correlations are depicted in Table 9.

Structural Equation Modelling

Figure 4 depicts the primary hypotheses tested with structural equation modelling. As before, all items were entered as observed variables. Error terms for difficulty and unpleasantness were allowed to covary, as were those for arrogance and confidence. The model provided a good fit to the data, $\chi^2 (3, N = 438) = 2.48, p = .480, \chi^2/df = 0.825$; CFI = 1.00; RMSEA = .000; SRMR = .017. Author arrogance predicted how difficult ($DE = .22, p < .001$) and unpleasant ($DE = .40, p < .001$) competitors felt it would be to compete with them, while author confidence predicted difficulty ($DE = .20, p < .001$) but not unpleasantness ($DE = .07, p = .195$). Difficulty ($DE = -.35, p < .001$) but not unpleasantness ($DE = .05, p = .391$) predicted table choice, and both confidence and arrogance had indirect associations with table choice through difficulty ($IE = -.07, p = .001$, and $IE = -.08, p < .001$, respectively).

¹⁰ Analyses in this paper treat table-choice percentages as continuous outcomes. Comparable analyses treating them as binomial show no substantive differences (see Appendix B).

Table 9.*Means, standard deviations, and zero-order inter-correlations for Study 3.*

	M (SD)	1	2	3
1. Difficult to Deal With	2.60 (0.53)	-		
2. Unpleasant	2.82 (0.57)	.56***	-	
3. Table choice (right)	0.78 (0.19)	-.36***	-.16**	-
4. OCQ Overconfidence	0.00 (0.77)	.11*	.12**	-.06
5. Confidence	2.71 (0.38)	.31***	.13**	-.25***
6. Arrogance	1.72 (0.44)	.32***	.36***	-.14**
7. Gender (Male)	1.36 (0.48)	-.03	.12*	.03
8. Word Length	120.67 (68.86)	.23***	.13**	-.12**
9. OCQ Accuracy	0.00 (0.90)	.07	.01	-.04

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.*Note.* Trait and overconfidence inter-correlations are omitted as they are redundant with Table 8.

Confidence also had a direct association with table choice ($DE = -.16, p = .002$), and a significant total association ($TE = -.24, p < .001$), while arrogance had no significant direct ($DE = .04, p = .501$) or total ($TE = -.02, p = .683$) associations with table choice. Author overconfidence had positive total indirect associations with unpleasantness ($IE = .06, p = .002$) and difficulty ($IE = .06, p = .001$) and a total indirect association, through all mediators, with less competitive table choice on the part of competitors ($TE = -.03, p = .034$). Note that the small effect size of this (multi-step) indirect association likely explains the lack of zero-order association between overconfidence and table choice (Kenny & Judd, 2013).

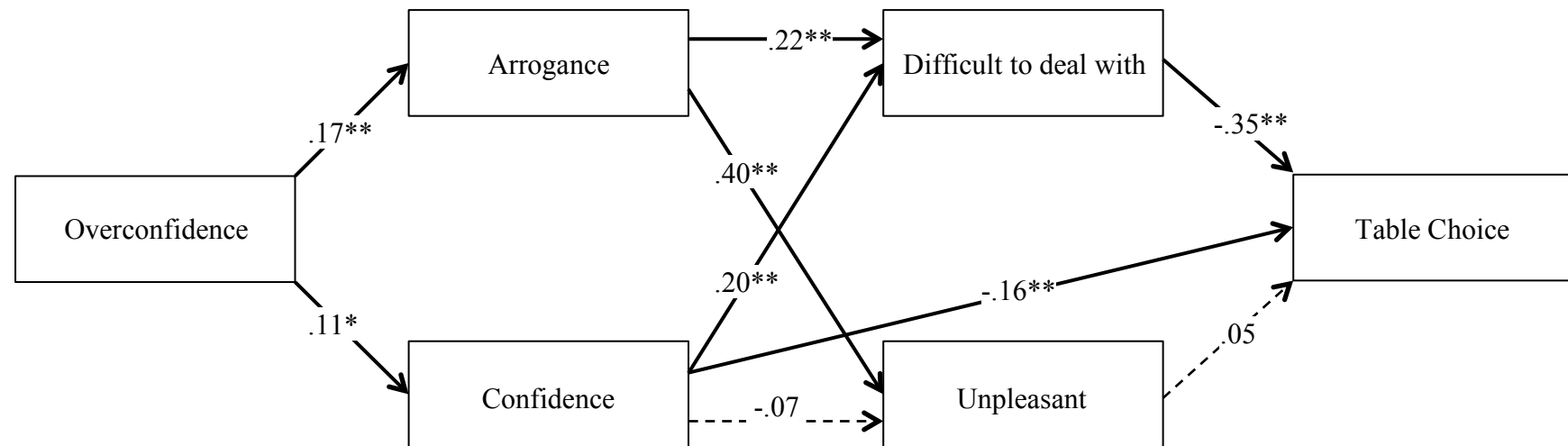


Figure 4. Study 3: Structural equation model of the effects of authors' overconfidence on competition outcome variables with confidence and arrogance as mediating variables. Relationships between the observed variables are shown.

$*p \leq .05$, $**p \leq .01$; $N=438$.

Discussion

Consistent with the hypothesis that overconfident individuals would benefit in mate competition because of their displayed confidence and arrogance, people were less willing to compete with profile authors who appeared confident and arrogant. Further, overconfidence was associated with increased perceptions that authors were difficult to compete with, and thus with a lower likelihood that competitors would choose to compete with them in the hypothetical scenario. Instead, competitors were more likely to sit at a different table when an overconfident individual already occupied the table with their preferred partner. Although both arrogance and unpleasantness were associated with competitors being less willing to sit with the authors, these relationships were weaker than those of confidence and difficulty, respectively, and were not significant in the full model. These results indicate that while arrogant individuals do ward off competitors, this is largely because they also tend to be perceived as confident.

Study 4

Study 3 illustrates that overconfident individuals may reduce others' willingness to compete with them, giving them an advantage in mate competition. But I have yet to consider the case when overconfident individuals are themselves deciding whether to compete for a mate. As outlined previously, evolutionary models suggest that in competitive situations where the rewards are high and the costs relatively low, people who overestimate their chances of success can achieve better outcomes because they are more willing to compete with others for valuable resources (D. D. P. Johnson & Fowler, 2011). Mating contexts in which it is unlikely that competition will escalate into violence (such as the table choice task in the current research) represent just such a situation. Thus, in addition to deterring *others* from competing with *them*, overconfident individuals may gain an advantage if their overconfidence makes *them* more likely to compete with *others* for a romantic partner.

To test this possibility, Study 4 extended the table-choice scenario. All participants completed a set of overconfidence measures and wrote a dating profile before being assigned to one of two groups: the authors, who finished the study after writing their profile, and the competitors, who were then given the opportunity to compete with the authors in a version of the table choice task from Study 3. This design allowed me to assess the role of overconfidence on both sides of the competition. To encourage individuals to make realistic decisions about whether they would compete, the stakes of the table choice task were also increased by giving competitors the opportunity to win money.

A final goal of Study 4 was to replicate the previous findings and test the new predictions with multiple measures of overconfidence. The previous studies relied solely on the Over-Claiming Questionnaire to tap overconfidence. Although this measure has clear advantages (a lack of obvious demand characteristics and minimal common method variance with the dating profile), there is always a risk that a single measure may have idiosyncratic properties that cause the observed effects. Accordingly, in Study 4 two new measures of overconfidence were added to form a latent overconfidence factor.

Method

Participants

Authors and *Competitors* were heterosexual North Americans ($N = 1134$; 40.1% female, $M = 28.83$ years) recruited through Mturk as in the prior studies (26 profiles were removed for the reasons outlined in the previous studies, leaving 1108 usable participants). After 467 authors completed the measures and wrote their profiles, the remaining 641 participants were assigned to be competitors, who also competed against the authors in the table choice task.

Raters were heterosexual North Americans ($N = 482$; 59.3% female, $M = 29.58$ years) recruited through Mturk to rate the profiles written by both authors and competitors. Each rater rated 25 profiles, leading to an average of 11 ratings per profile.

Procedure and Measures

Overconfidence. Authors and competitors completed three measures of overconfidence. First they completed two measures that operationalised overconfidence as the discrepancy between performance and self-evaluation (Ames & Kammrath, 2004; Anderson et al., 2012; Kruger & Dunning, 1999). I created vocabulary and general knowledge tests for this purpose. Each test consisted of 25 multiple-choice questions gathered from online sources and pre-tested for an average accuracy of 75%. To prevent participants from searching for answers online, questions had ten second time limits. After each test, participants rated their performance compared to fellow Mturk workers on a 100-point percentile scale. In accordance with previous research (Anderson et al., 2012; Bonanno et al., 2002; Paulhus, 1998), the percentile self-ratings were regressed on the participants' actual scores, saving the standardised residuals as measures of knowledge overconfidence and vocabulary overconfidence. Participants then completed a 25-item form of the OCQ, which had been validated against the larger scale (Bing & Davison, 2012, October).

Dating profile measure. Both authors and competitors wrote a dating profile using the instructions from Study 2.

Table choice measure. After completing the above measures, the competitors proceeded to perform the table-choice task as in Study 3, competing against the profiles of the authors. To provide real consequences for their decisions, competitors were told that

Table 10.

Means, standard deviations, and zero-order inter-correlations for Study 4 trait ratings.

	M (SD)	1	2	3	4	5	6	7	8	9	10	11	12	13
1. OCQ Overconfidence	0.00 (0.66)	-												
2. Knowledge Overconfidence	0.00 (1.00)	.08**	-											
3. Vocabulary Overconfidence	0.00 (1.00)	.16***	.52***	-										
4. Confidence	4.96 (0.68)	.09**	.09**	.09**	-									
5. Arrogance	3.11 (0.84)	.05	.07*	.05	.44***	-								
6. Desirability	4.10 (0.75)	.07*	-.01	-.01	.43***	-.23***	-							
7. Social Status	3.85 (0.72)	.11***	.01	-.01	.58***	.20***	.56***	-						
8. Intelligence	4.68 (0.81)	.12***	.03	.01	.42***	-.08*	.68***	.62***	-					
9. Creativity	4.28 (0.83)	.14***	-.01	-.01	.36***	-.10**	.55***	.30***	.55***	-				
10. Humour	3.74 (0.70)	.06*	-.04	-.01	.28***	-.03	.43***	.12***	.27***	.45***	-			
11. Gender (Male)	0.60 (0.49)	.00	.22***	.14***	.07*	.01	-.06*	.03	.05	-.01	-.04	-		
12. Word Length	104.26 (50.25)	-.02	.01	.01	.20***	.20***	.06*	.13***	.15***	.18***	.16***	-.04	-	
13. OCQ Accuracy	0.00 (1.03)	.07*	-.01	.01	.06*	-.01	.13***	.10***	.25***	.23***	.15***	-.10***	.08**	-

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

choosing the non-competitive table would guarantee them a \$.10 bonus payment for each table choice. If they chose the competitive table, however, they would earn \$.20 if they were rated as more desirable than the author but \$0 if not. Several questions probed their understanding of these instructions before they continued.

Dating profile rating. Raters read the profiles of both authors and competitors, rating them on confidence, arrogance, and desirability. To increase the range of responses, the ratings were given on a seven-point scale ranging from 1 (*Not at all like this person*) to 7 (*Very much like this person*). A new dichotomous desirability measure also asked the rater whether they would be willing to go on a date with each profile-writer.

Results

Overconfidence and Desirability

Because author and competitor profiles were both evaluated by raters, all of their profiles ($N = 1108$) were used to examine the effects of the latent overconfidence variable on arrogance, confidence, and desirability. Means, standard deviations, and zero-order correlations are reported in Table 10.

Structural equation modelling. Figure 5 depicts tests of the effects of overconfidence on rated desirability via structural equation modelling. The three overconfidence measures were entered as observed variables loading onto a latent overconfidence variable with its variance scaled to 1. The model provided a relatively good fit to the data, $\chi^2 (7, N = 1108) = 17.92, p = .012, \chi^2/df = 2.57$; CFI = 0.99; RMSEA = .038; SRMR = .025. The latent overconfidence factor predicted raters' perceptions of the confidence ($DE = .12, p = .002$) and arrogance ($DE = .07, p = .046$) of the profiles. Examination of the indirect effects of overconfidence on desirability revealed a positive

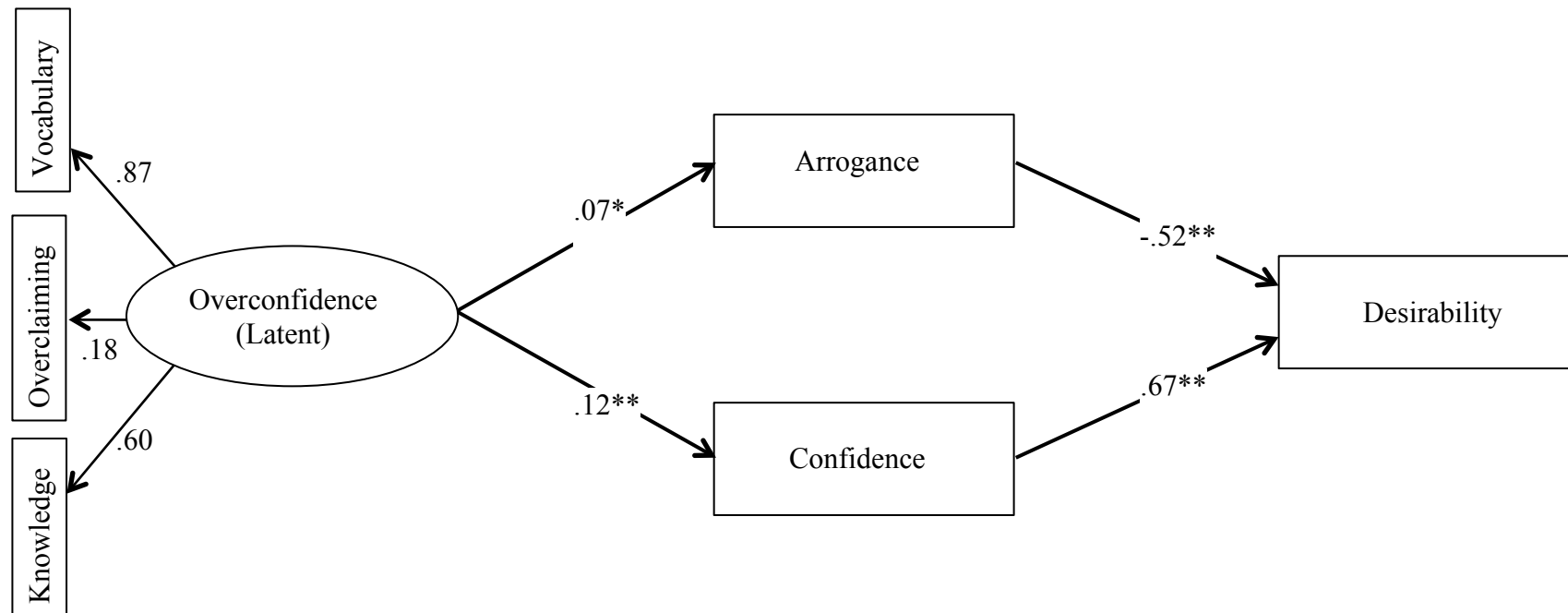


Figure 5. Study 4: Structural equation model of the effects of authors' and competitors' latent overconfidence on desirability with confidence and arrogance as mediating variables. Relationships between variables of interest are shown.

* $p \leq .05$, ** $p \leq .01$; $N = 1108$.

Table 11.

Means, standard deviations, and zero-order inter-correlations for Study 4 deterrence effects.

	M (SD)	1	2	3
1. Difficult	2.56 (0.46)	-		
2. Unpleasant	2.74 (0.47)	.40***	-	
3. Table choice (right)	0.65 (0.23)	-.39***	.11*	-
4. OCQ Overconfidence	0.00 (0.66)	.02	-.04	-.06
5. Knowledge Overconfidence	0.00 (1.00)	.01	.07	.04
6. Vocabulary Overconfidence	0.00 (1.00)	.07	.14**	-.01
7. Confidence	4.96 (0.68)	.23***	-.08	-.42***
8. Arrogance	3.11 (0.84)	.27***	.24***	-.10*
9. Desirability	4.10 (0.75)	.06	-.31***	-.39***
10. Gender (Male)	0.60 (0.49)	-.05	.10*	.09*
11. Word Length	104.26 (50.25)	.11*	.01	-.23***
12. OCQ Accuracy	0.00 (1.03)	-.09	-.06	-.02

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

Note. Trait and overconfidence inter-correlations are omitted as they are redundant with Table 10.

indirect association through confidence ($IE = .08, p = .002$) and a negative indirect association through arrogance ($IE = -.04, p = .047$), resulting in a null indirect association overall ($TE = .04, p = .068$). A substantively equivalent pattern of effects was observed on raters' willingness to consider a date with the profile-writer (see Appendix B).

Overconfidence from the Author's Perspective: Deterring Competition

As in Study 3, for each author the scores they were given by competitors were averaged to create mean scores for how difficult and unpleasant to deal with they were perceived to be, and how frequently competitors chose to compete with them on table choice. Each author was assessed by an average of 7 competitors. Means, standard deviations, and zero-order correlations are depicted in Table 11.

Structural equation modelling. Figure 6 depicts the effect of author overconfidence on competitors' table choice, as estimated by structural equation modelling. The model was set up using full information maximum likelihood (FIML) estimation (Allison, 2003). This technique enabled me to use ratings of the entire sample ($N = 1108$) to estimate paths from overconfidence to confidence and arrogance, while using the sub-sample of 467 authors to estimate links to difficulty, unpleasantness, and table choice.

The model provided a relatively good fit to the data, $\chi^2(13, N = 1108) = 24.25, p = .029, \chi^2/df = 1.87$; CFI = 0.99; RMSEA = .028; SRMR = .030. As in Study 3, arrogant authors were perceived as more difficult to deal with ($DE = .24, p < .001$) and unpleasant, ($DE = .36, p < .001$), while confident authors were perceived as more difficult ($DE = .15, p = .002$). In contrast to Study 3, in which there was no effect of confidence on unpleasantness, confident authors were now perceived as less unpleasant ($DE = -.22, p < .001$). As in Study 3, authors perceived as difficult were the targets of less competitive table choice ($DE = -.43, p < .001$), but whereas unpleasantness had no effect on table choice in Study 3, unpleasant authors in Study 4 were the targets of more competitive table choice ($DE = .23, p < .001$).

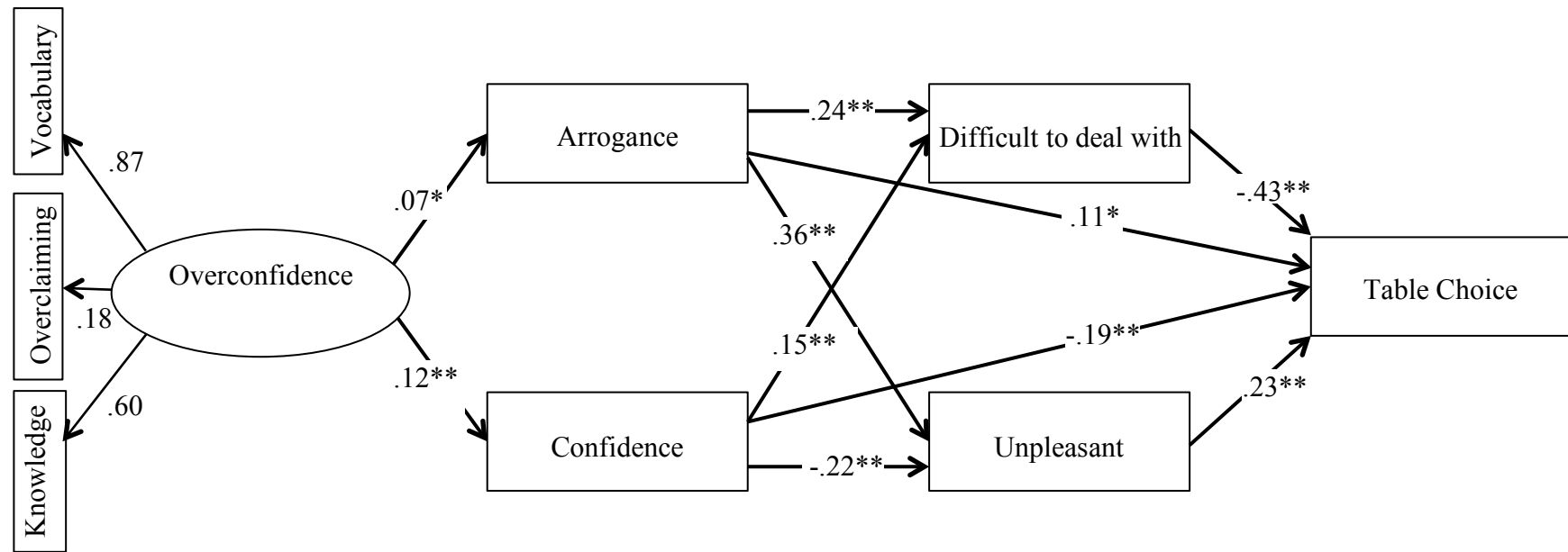


Figure 6. Study 4: Structural equation model of the effects of authors' overconfidence on deterrence outcome variables with confidence and arrogance as mediating variables. Relationships between variables of interest are shown.

* $p \leq .05$, ** $p \leq .01$; $N=1108$ for direct links from overconfidence, $N=467$ for other links.

Replicating Study 3, author confidence was indirectly associated with less competitive table choice through perceptions of difficulty ($IE = -.07, p = .004$), and was also directly associated with less competitive table choice ($DE = -.36, p < .001$). In contrast to Study 3, confidence was also indirectly associated with less competitive table choice through decreased perceptions of unpleasantness ($IE = -.05, p = .001$). These effects led to a significant total association of confidence with less competitive table choice, as in Study 3 ($TE = -.47, p < .001$). As in Study 3, arrogance had an indirect association with less competitive table choice through difficulty ($IE = -.10, p < .001$), but unlike Study 3, arrogance was associated with more competitive table choice both directly ($DE = .11, p = .023$) and through unpleasantness ($IE = .08, p < .001$). As in Study 3, this combination led to no total effect of arrogance on table choice ($TE = .09, p = .072$). In contrast to Study 3, overconfidence no longer had any indirect association with unpleasantness ($IE = .00, p = .978$), but did retain its positive indirect association with difficulty ($IE = .04, p = .011$) and a negative total indirect association with table choice, ($TE = -.05, p = .004$), such that overconfident authors were competed against less.

Overconfidence from the Competitor's Perspective: Facilitating Competition

The analyses above tested whether overconfident *authors* were competed against *less*. I next examined whether overconfident *competitors* might choose to compete *more*. In contrast to the previous analysis, competitors are now the unit of analysis, and so, for each competitor, the average of their five table choice decisions was taken to calculate how willing they were to compete. I also included a new outcome variable; the amount of money that competitors won from their decisions. Competitors won a contest if they chose to compete and their rated desirability was higher than the desirability of the author whose profile they had viewed. Means, standard deviations, and zero-order correlations are depicted in Table 12.

Table 12.

Means, standard deviations, and zero-order inter-correlations for Study 4 competitor effects.

	M (SD)	1	2
1. Table choice (right)	0.66 (0.31)	-	
2. Money won	0.54 (0.27)	0.08	-
4. OCQ Overconfidence	0.00 (0.66)	0.08*	0.07
5. Knowledge Overconfidence	0.00 (1.00)	0.04	0.02
6. Vocabulary Overconfidence	0.00 (1.00)	0.05	-0.01
7. Confidence	4.96 (0.68)	0.23***	0.23***
8. Arrogance	3.11 (0.84)	0.08*	-0.22***
9. Desirability	4.10 (0.75)	0.16***	0.71***
10. Gender (Male)	0.60 (0.49)	0.06	0.01
11. Word Length	104.26 (50.25)	0.22***	-0.03
12. OCQ Accuracy	0.00 (1.03)	-0.01	0.10*

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

Note. Trait and overconfidence inter-correlations are omitted as they are redundant with Table 10.

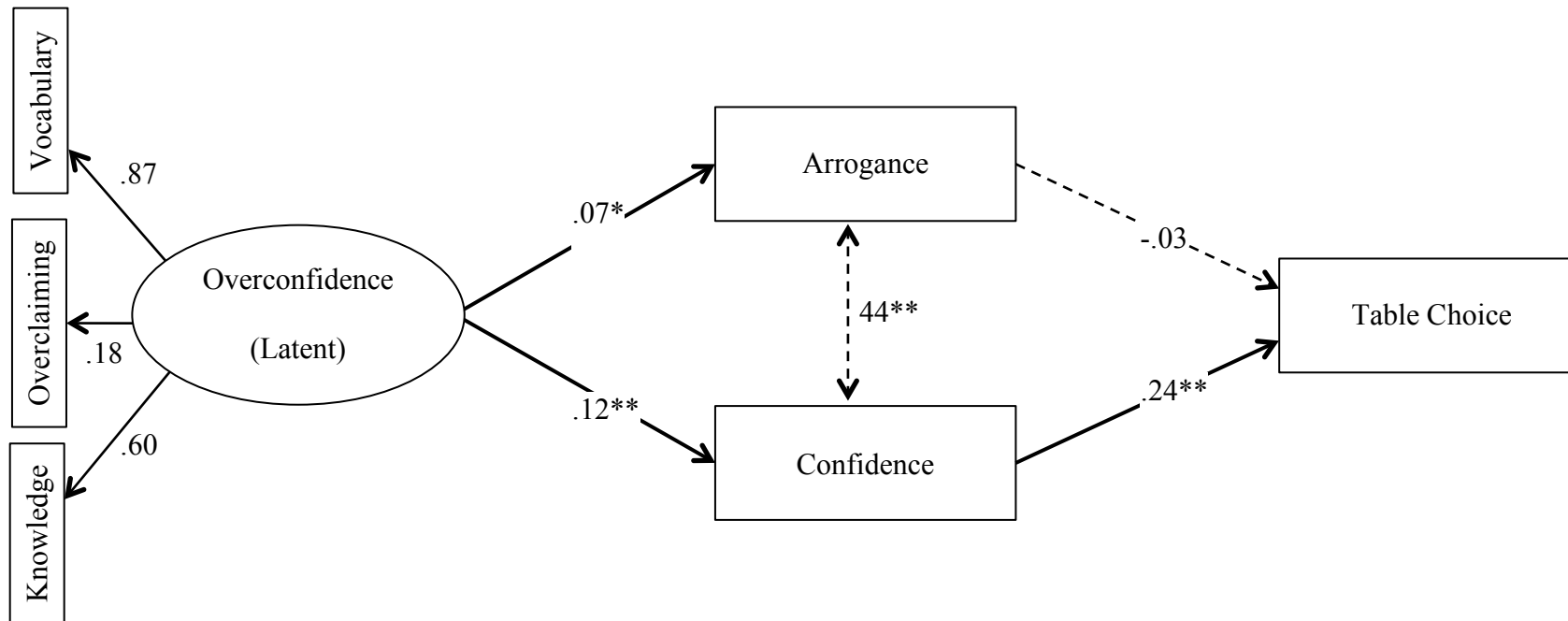


Figure 7. Study 4: Structural equation model of the effects of competitors' latent overconfidence on competitors' table choice with confidence and arrogance as mediating variables. Relationships between variables of interest are shown.

* $p \leq .05$, ** $p \leq .01$; $N=1108$ for direct links from overconfidence, $N=641$ for other links.

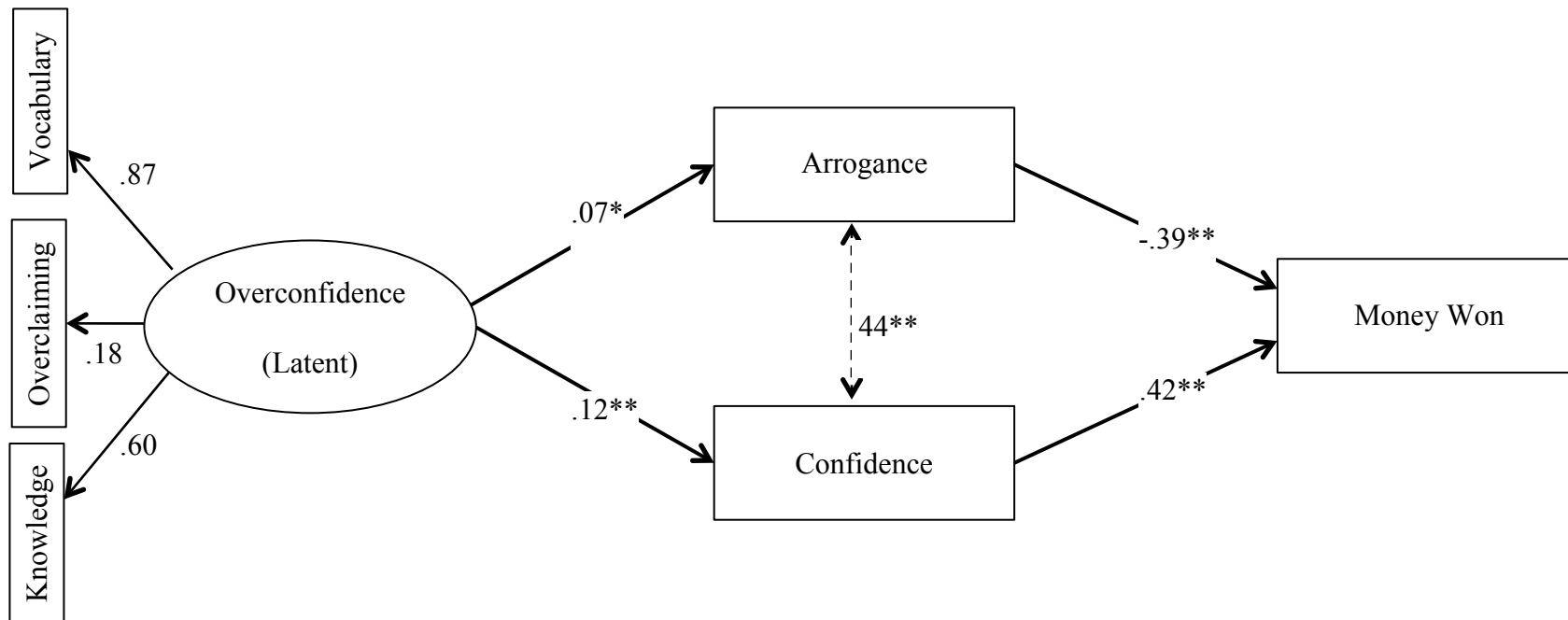


Figure 8. Study 4: Structural equation model of the effects of competitors' latent overconfidence on competitors' money won with their confidence and arrogance as mediating variables. Relationships between variables of interest are shown.

* $p \leq .05$, ** $p \leq .01$; $N=1108$ for direct links from overconfidence, $N=641$ for other links.

Structural equation modelling. Figure 7 depicts tests of the effect of competitors' overconfidence on their table choice via structural equation modelling. The model was set up as in the previous analysis, and provided a relatively good fit to the data, $\chi^2 (7, N = 1108) = 12.57, p = .083, \chi^2/df = 1.80$; CFI = 0.99; RMSEA = .027; SRMR = .024. Competitors who wrote profiles that were perceived as more confident ($DE = .24, p < .001$) but not more arrogant ($DE = -.03, p = .487$) were more likely to choose to compete. Competitors' overconfidence was indirectly associated with increased competition through perceived confidence ($IE = .03, p = .006$) but not through perceived arrogance ($IE = .00, p = .512$), and had an overall indirect association with increased competition ($TE = .03, p = .006$).

Figure 8 depicts the same model as Figure 7, but with the amount of money won from competition as the outcome variable. The model again provided a relatively good fit to the data, $\chi^2 (7, N = 1108) = 15.16, p = .034, \chi^2/df = 2.17$; CFI = 0.99; RMSEA = .032; SRMR = .024. Confidence was associated with an increase in the amount of money won ($DE = .42, p < .001$), while arrogance was associated with less money won ($DE = -.39, p < .001$). Overconfidence was indirectly associated with more money won through confidence ($IE = .05, p = .002$) and with less money won through arrogance ($IE = -.03, p = .050$), leading to a null overall indirect effect ($TE = .02, p = .173$).

Mixed-effects models of author-competitor interactions. To examine the interaction between author and competitor characteristics on competition outcomes, I next analysed the data at the level of individual table choice decisions. Linear mixed-effects modelling was performed using the *lme4* package in R to control for the non-independence caused by having multiple observations for each author and each competitor (Baayen, Davidson, & Bates, 2008). Analyses revealed no significant interactions between the overconfidence of the author and competitor in predicting table choice or money won. Models with all author-competitor confidence and arrogance interactions specified revealed

no interactions predicting table choice. There were, however, interactions between competitor confidence and author arrogance ($B = .004$, $SE = .001$, 95% CI [.001, .006]) and confidence ($B = -.003$, $SE = .001$, 95% CI [-.006, -.001]) in predicting money won, such that competitor confidence conferred a smaller monetary benefit when competing against more confident authors, and a larger benefit when competing against more arrogant authors. There were no such interactions for competitor arrogance, and no significant three-way interactions.

Discussion

The results of Study 4 replicated the previous findings that overconfident authors are perceived as more confident and arrogant, and that although these qualities have a neutral overall effect on desirability, they effectively deter competitors who read their profiles. The replication of this pattern of results with a latent factor constructed from multiple measures of overconfidence is evidence that these findings are not artefacts of the Over-Claiming Questionnaire.

The results also revealed that overconfident people are more likely to engage in mate competition, which in this study meant betting money that they would be found more desirable than the other individual. These effects of overconfidence remained indirect, however, and were such that overconfident individuals were more willing to compete to the extent that they projected more confidence, but not more arrogance. Although they were more willing to compete, overconfident individuals did not win more money, because overconfidence did not increase desirability (as in previous studies).

As might be expected, the addition of the monetary incentives seems to have shifted the basis of decision-making in the table choice task. In the hypothetical scenario of Study 3, people visualised themselves competing with confident and arrogant individuals for a target's romantic attentions, and were deterred in part by the anticipated unpleasantness of competing with an arrogant individual. In contrast, in Study 4 the incentives required only that

participants be seen as more desirable for them to win the competition, and thus they were not deterred by the hypothetical unpleasantness of their competitors (whom they may have accurately presumed to be less attractive). As a consequence, the association between arrogance and table choice diminished. Despite this shift, the total indirect association of overconfidence with table choice remained, indicating that overconfidence can effectively deter competitors solely through perceptions of the increased difficulty of competing with overconfident individuals.

Study 5

The results of the first four studies suggest that overconfidence is associated with increased perceptions of confidence and arrogance that appear to have a net zero effect on mate attraction due to their countervailing effects on desirability. Nonetheless, the results of these studies also highlight the possibility that overconfidence, even though it often comes across as arrogance, might enhance mating success by driving away the competition. One way to test this possibility is through agent-based modelling, which can offer insight into how these effects impact outcomes and interact with one another under different environmental conditions.

Agent-based modelling involves programming behavioural rules into a large number of hypothetical actors, and examining the resulting effects on the system as a whole, as well as the actors in the system. This type of model has a long history in the social sciences; one of the first applications was Schelling's (1971) famous model of segregation, which showed that a mild preference to be around similar individuals could lead to complete segregation (for a more recent example, see Gray et al., 2014). Agent-based modelling allows for the examination of the expected value of overconfidence – as manifested in confidence and arrogance – on mating success in a variety of situations. Specifically, agent-based models can be used to assess how the costs and benefits of confidence and arrogance fluctuate under

more or less competitive pressure. Modelling different levels of competition can thus test whether competitive pressures cause the combination of confidence and arrogance typically associated with overconfidence to become beneficial.

I hypothesised that under low levels of mate competition, the benefits of confidence and the costs of arrogance would negate each other as has been seen in the prior experiments. Under increased competition, however, the combined effects of confidence and arrogance on mate acquisition should become more positive. Thus, overconfidence should have a net positive effect at higher levels of romantic competition.

Method

Creating the Model

I based the simulations on a scenario extended from the table-choice tasks. In the simulations, individuals are imagined as searching for potential partners in an environment rich with targets and competition. In each simulation, varying numbers of individuals approach a potential partner. The confidence and arrogance displayed by each individual affects the chance of his or her advances being accepted by the target, the likelihood that they would be willing to compete for the target, and their likelihood of deterring competitors from doing the same.

I ran the following simulation for every number of competitors (k) from 0 to 20, with 0 representing a lone individual with no competition. To begin each simulation, I used the ‘mvrnorm’ function in R to generate a population of $1000 \times (k+1)$ individuals whose perceived confidence and arrogance fit the empirical distribution of the data collected so far (i.e., means, SDs, and the correlation between confidence and arrogance; using standardised scores for arrogance and confidence). I then used the binary choice data from Study 4 to estimate the likelihood that a target would find each individual desirable enough to accept his or her advances. I calculated the probability that each individual would be found desirable based on

their confidence (C) and arrogance (A), including residual error variance (E), in accordance with the regression equation derived from the data.

$$P_{desire} = .488 + .103C - .104A + E.$$

I then broke the individuals into 1000 groups of $k + 1$ competitors each. Where k was greater than 0, I calculated each individual's likelihood of competing with each other individual in their group based on both of their confidence and arrogance scores, according to the equation below. Here, characteristics of decision makers are marked with a 1; those of competitors currently being assessed are marked with a 2. Coefficients for decision maker characteristics that influence competition are drawn from Study 4, while coefficients for competitor characteristics are drawn from Study 3 to estimate the effects of arrogance and confidence when competitors imagined an interaction with the author.

$$P_{compete} = .658 + .077C^1 - .011A^1 - .044C^2 - .004A^2 + E$$

After calculating $P_{compete}$, I assessed the likelihood that each individual would remain to compete for the target by taking the cumulative product of his or her likelihood to compete with each individual competitor. This is conceptually equivalent to an individual facing (for example) three competitors, making independent decisions about whether it is worth competing against each of the three, then staying to compete if the result of all of their decisions was *yes*.

$$P_{stay} = P_{compete1} * P_{compete2} * \dots * P_{compete\ k-1}$$

I then updated P_{desire} for each individual, multiplying it by his or her P_{stay} . In this way, I account for the fact that one needs to stay to compete to have a chance of being desired. In the 0 competitor scenario, P_{stay} was set to 1.

$$P_{desire} = P_{desire} * P_{stay}$$

I next calculated P_{none} , which is the probability of the target choosing no one, and allows for the chance of a target refusing all advances if all competitors are found unacceptable.

$$P_{none} = (1 - P_{i_{desire}}) * (1 - P_{2_{desire}}) \dots * (1 - P_{n_{desire}})$$

Finally, I calculated the outcome variable, the probability of each individual being chosen by the target (P_{chosen}). First, each individual's P_{desire} was divided by the sum of the P_{desire} of every individual in the group, giving the chance that they, of all competitors, would be chosen. This was then multiplied by the probability that the target would choose any of the competitors to account for the target's chance of leaving alone.

$$P_{chosen} = (P_{i_{desire}} / (\sum(P_{i_{desire}}, P_{2_{desire}} \dots P_{n_{desire}}))) * (1 - P_{none})$$

For each number k of competitors, I then saved the standardised betas of confidence and arrogance simultaneously predicting P_{chosen} among the $1000 * k$ individuals. To account for variability in simulations, I repeated the above process 40 times for each level of k and averaged the results.

Results

Below are plotted the results of this simulation on the expected values of arrogance, confidence, and the combination of the two that is typically seen in overconfidence. As the ratio of the two traits that is associated with overconfidence is not identical between Studies 2 and 4, I mixed the two evenly, although the shape of the relationship is largely unaffected by varying ratios. Note that these estimates are of the direct effects of the sum of arrogance and confidence, not the smaller indirect effects of overconfidence. Figure 9 shows the results of this simulation when the effects of confidence and arrogance are restricted to deterring competitors. Figure 10 shows the effects when arrogance and confidence are also allowed to increase one's own propensity to compete.

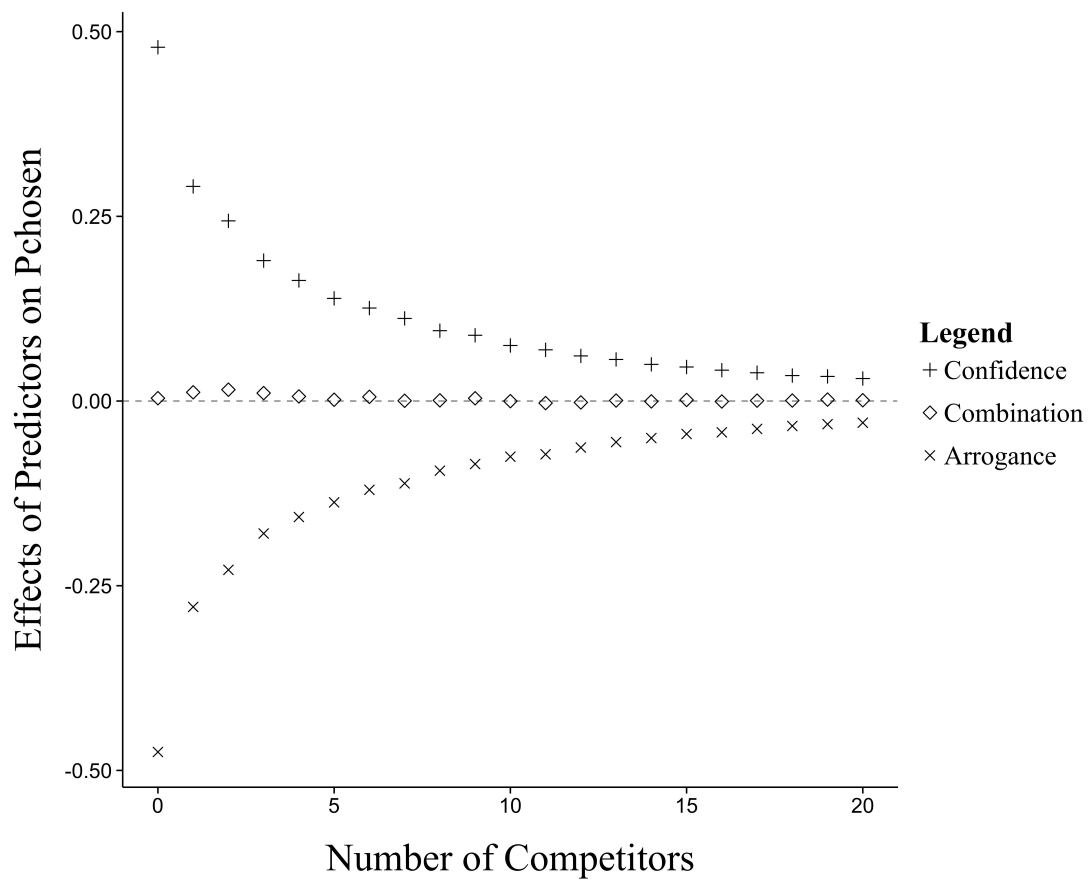


Figure 9. Study 5. Estimated effects of confidence, arrogance, and the sum of the two on the probability of mating success under Stage 1 of the agent-based model, in which only deterrence effects are active.

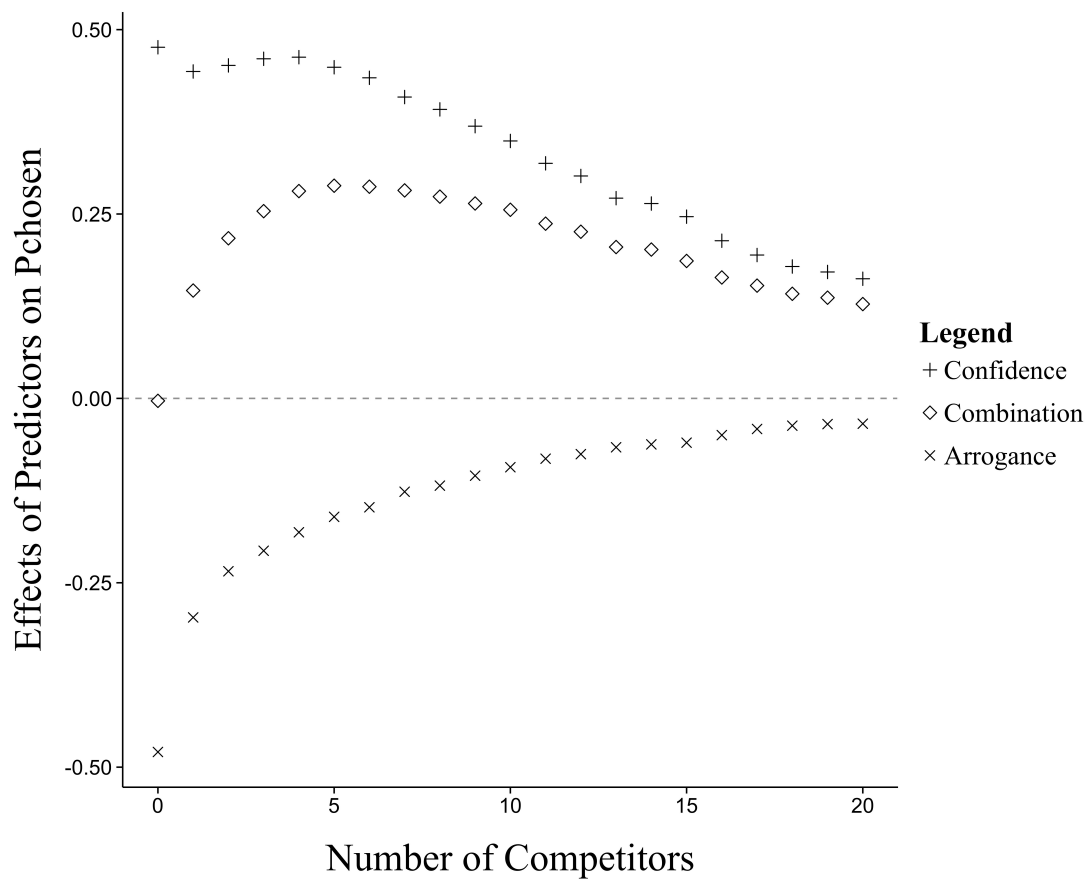


Figure 10. Study 5. Estimated effects of confidence, arrogance, and the sum of the two on the probability of mating success under Stage 2 of the agent-based model, in which all effects are active.

The first thing that becomes clear is that under the more minimal conditions of the model in Figure 9, the deterrent effects of confidence and arrogance shift the estimated effects of their combination from neutral to slightly positive under low levels of competition, but this benefit is quite small and disappears under increasing levels of competition. Under the fuller model in Figure 10, however, the effect of the combination of confidence and arrogance rapidly becomes highly beneficial, and remains beneficial under high levels of competition, though the estimated effects peak at around 5 competitors.

This finding suggests that the increase in willingness to compete associated with confidence and arrogance seems to be responsible for the majority of their positive effects under competition. This finding also indicates that the deterrence effects of confidence and arrogance diminish in strength when more than a few competitors are present. Though there are more competitors to deter, each competitor is assessing more and more individuals, diminishing each individual's contribution to their decision. In contrast, people's willingness to compete is applied to every decision they make, and so the effect of confidence and arrogance on willingness to compete contributes more to their decision to stay when more competitors are present. As the number of competitors grows very high, the effect of any individual traits diminish as the desirability of other competitors in the group increasingly affects an individual's chances of success. Thus the effectiveness of arrogance and confidence is highest with an intermediate number of competitors.

Discussion

Using agent-based modelling I was able to estimate how confidence and arrogance could affect mate acquisition under varying levels of competition. Through this modelling it can be seen that the combination of confidence and arrogance that is associated with overconfidence becomes beneficial under moderate to high levels of mate competition. Of course, this model assumes that the effects of confidence and arrogance on decision making

remain constant as competition levels increase. It is impossible to know for sure how these effects might change in high-competition scenarios without further research. Nevertheless, these simulations derived from the empirical relationships found in Studies 2, 3 and 4 indicate that overconfidence can substantially improve an individual's potential for romantic success in competitive settings.

General Discussion

The results of four empirical studies and agent-based modelling provide evidence for the role of overconfidence in mate acquisition and competition. In Study 1, overconfident people were perceived as more confident in their dating profiles, and confident profiles were perceived as more desirable, but there was no zero-order association between overconfidence and romantic desirability. The results of Study 2 provided evidence for countervailing forces underlying overconfidence, whereby the positive effect of confidence on desirability was suppressed by the negative effect of arrogance. Thus, overconfident people increase their romantic desirability by appearing confident but they concurrently decrease their romantic desirability by displaying arrogance.

Study 3 demonstrated a benefit of overconfidence in the domain of mate competition; perceived confidence and arrogance led to increased deterrence of competitors for romantic attention. Although this deterrence effect was partially mediated by the perceived difficulty and unpleasantness of competing with overconfident individuals, these need not be the only reasons that individuals chose not to compete. For instance, potential competitors might have thought that they could match the confidence and arrogance of the author, but were nonetheless unwilling to do so because of the potential negative impression that this would leave on the romantic target. Future studies could disentangle these possibilities by varying where the competition takes place, either before approaching the target or in the presence of the target. Either way, overconfident individuals were able to

reduce their pool of competitors for romantic targets, suggesting that overconfidence might be beneficial despite typically not being more romantically desirable.

Study 4 found that, to the extent that overconfident individuals appeared more confident, they were more willing to gamble that they would be chosen as a romantic partner (although they did not win additional money from their increased competition). Thus, the data from Study 4 suggest that overconfident individuals are more likely to deter mate competition and less likely to be deterred. Study 4 also replicated the previous results with a latent variable created from three different measures of overconfidence (despite the fact that none of these measures of overconfidence tapped people's self-perceived desirability as a dating partner).

It is worth addressing why in Study 4 the increased willingness of overconfident individuals to compete was mediated by the confidence others saw in their dating profiles, rather than being a direct effect of overconfidence itself. It seems likely that this mediation is due to the fact that the measure of confidence throughout this paper is more closely associated with romantic decision-making than are the measures of overconfidence. Individuals' decisions to compete should be directly affected by confidence in their romantic abilities, of which the best available measure is the perceived confidence with which they wrote dating profiles. In contrast, overconfidence was measured in abstract intellectual domains, which are rather far removed from romantic activities (indeed, many people probably have great confidence in their intellectual abilities and little confidence in their romantic ones). Thus, the measure of romantic confidence, which is more proximal to the decision to compete, mediates the effects of overconfidence as measured here.

It seems likely that a study that measured overconfidence in romantically relevant traits such as appearance, earning potential, or sexual prowess, might find more direct effects of overconfidence on romantic competition. While most romantic traits are difficult to

objectively measure, overconfidence in physical attractiveness may be a promising avenue for future work. This can be measured by comparing self-ratings of attractiveness to the average attractiveness ratings of standardised photographs, but more direct measures are also available. For instance, Epley and Whitchurch (2008) morphed facial photographs of their participants to varying degrees with attractive and unattractive models, and then asked their participants to find their actual face in an array of such morphs. They found that participants were more likely to choose a photo morphed 10% with the more attractive image than either their actual photo or their photo morphed with the unattractive image, suggesting that most participants were overconfident about their own attractiveness. Such measures may prove useful in future investigations of romantic overconfidence.

In Study 5 agent-based simulations indicated that the effects of overconfidence in mate competition and acquisition vary according to the number of competitors. At moderate to high levels of competition, the negative effects of arrogance were diminished, and the positive effects of confidence strengthened, leading to positive estimates of the combination of the two on expected mating success. These data are consistent with the notion that overconfidence benefits mating success primarily through its role in intra-sexual competition.

The current research revealed a nuanced pattern of costs and benefits of overconfidence to romantic desirability, but previous studies have found that overconfident people reap only benefits, being perceived as competent with little apparent cost (Anderson et al., 2012; Lamba & Nityananda, 2014). It is an open question why the costs of arrogance found here were not apparent in these other settings. Do people scrutinise others less in settings that do not involve romantic attraction? Does arrogance matter less in such settings, so long as we think our teammates are competent? Or is it easier for overconfident people to avoid the appearance of arrogance in these settings? Future work could extend the analysis of confidence and arrogance presented here into competence-based settings to distinguish these

possibilities. Given that overconfident people gained an advantage in the current research when in a competitive mating environment, it would be interesting to test whether the benefits of being overconfident in other settings are also greater when the environment is competitive.

Finally, I should note that although these studies repeatedly showed that the countervailing effects of confidence and arrogance led to null effects of overconfidence on romantic desirability at the sample level, this null effect did not uniformly emerge at the individual level. The moderate size of the correlation between arrogance and confidence indicates that many individuals benefit from overconfidence by projecting confidence in the absence of arrogance, while others pay a cost for their overconfidence by projecting arrogance but little confidence. The role of overconfidence in causing people to project one or the other is likely to be moderated by various factors such as social skills, reputation, and attractiveness. Because individuals who can project confidence but not arrogance will benefit strongly in both mate attraction and mate competition, the factors underlying this ratio of perceived confidence to arrogance would seem to be a worthwhile area for further research.

Conclusions

The current studies showed that overconfident self-beliefs can create a net advantage that increases mating success in competitive environments, despite the costs associated with overconfidence. In line with social theories for the adaptive role of overconfidence (Trivers, 2011; von Hippel & Trivers, 2011), the current work suggests that overconfidence might not only induce people to place risky bets, but might actually help them win—at least if they are gambling in the game of love.

Chapter 4: General Discussion

Summary of findings

In this thesis, I examined the adaptive role of overconfidence by testing for its potential benefits on mental health, motivation, and popularity in a comprehensive longitudinal study. I also examined the potential social benefits of overconfidence by testing whether these benefits were mediated through increased perceptions of confidence. Finally, I investigated multiple ways in which overconfidence could benefit individuals in their pursuit of romantic success: through romantic desirability, competitor deterrence, and increased willingness to compete for partners.

In Chapter 2, overconfidence in physical ability led individuals to increase the time they devoted to improving their physical capacities and this resulted in increased ability over time. Further, physical overconfidence led to substantial benefits in popularity. While overconfidence in intelligence did not show the same benefits, neither did it show any costs. It remains to be seen whether the lack of benefits for intelligence overconfidence was due to genuine differences in the effects of the different forms of overconfidence. Both forms of overconfidence were associated with better mental health cross-sectionally, although they did not affect change over time. Despite the differences between intelligence and sporting domains, this test of the adaptive accounts of overconfidence found some support for all three adaptive hypotheses, with no evidence for the theory that overconfidence is harmful over time.

Chapter 3 built on the finding that overconfidence can create real-world social success by investigating the pathways through which this happens, and also by extending the investigation to test whether overconfidence would have benefits in the romantic domain. The results revealed that to the extent that overconfidence created any benefits to desirability, competitor deterrence, and willingness to compete, these were driven almost entirely through

increased displays of confidence. Chapter 3 also highlighted one of the potential costs of overconfidence, as overconfident individuals in this series of studies were perceived not just as confident but also as arrogant, and to the extent that the latter was the case, they were less romantically desirable. Because of this associated increase in arrogance, overconfidence did not lead to an increase in romantic desirability as was observed (analogously) with the effect of sporting overconfidence on popularity in Chapter 2.

This discrepancy raises the question of whether the relationship between overconfidence and arrogance can explain the difference in social outcomes between intelligence and sporting overconfidence in Chapter 2. In that study, intelligence overconfidence did not predict increased social success – a finding that was mirrored by the lack of a direct effect on romantic desirability in Chapter 3, where the measures of overconfidence were primarily intellectual. Without measures of perceived arrogance and confidence, it is impossible to know for sure, but it seems at least possible that the failure of both forms of intellectual overconfidence might have had the same root cause: arrogance.

If arrogance did indeed hurt intellectually overconfident people specifically in Chapter 2, it would suggest that arrogance is a risk that is associated with intellectual overconfidence rather than being specific to a romantic setting. The question would then be why sporting overconfidence led to social success when intelligence overconfidence did not? If the suppression relationship between the positive effects of confidence and the negative effects of arrogance identified in Chapter 3 was mirrored in Chapter 2, then the benefits of sporting overconfidence on network popularity could have stemmed from either increased perceptions of confidence, or decreased perceptions of arrogance. It is not immediately clear why sporting overconfidence would create a more positive confidence-to-arrogance ratio than intellectual overconfidence. Perhaps overconfidence in physical prowess triggers more effective, non-verbal displays of confidence, but this possibility is purely speculative at the

moment. Nonetheless, the notion that sporting overconfidence might lead to perceptions of more confidence or less arrogance than intellectual overconfidence is a promising area for future research.

Nonverbal displays of confidence

One limitation of the work presented in Chapter 3 is that the effects of overconfidence in a romantic setting were tested through written dating profiles only. Some might argue that it would be easier to ‘get away with’ overconfidence when hidden behind a keyboard, as one can claim anything without having these claims falsified. However, it is possible that this method may understate the positive effects of overconfidence. After all, many of the signals that display genuine confidence are nonverbal, and it has been shown that overconfident individuals display these nonverbal cues to confidence at an increased rate (Anderson et al., 2012). By limiting participants to presenting themselves through written dating profiles, overconfident people were unable to use non-verbal channels of communication to convey their increased confidence. This may have made them more likely to seem arrogant than if they had been able to act out the non-verbal behaviours associated with confidence, such as a relaxed posture and confident vocal tone.

To address this problem, overconfidence would need to be measured in a romantic setting that allowed for non-verbal communication. One possibility would be to use a speed-dating paradigm to allow individuals to meet in person for a short time, and test whether their overconfidence caused greater perceptions of confidence than in an online setting. If intellectual overconfidence does have benefits to romantic desirability when tested in person, it would suggest that the null effects found in Chapter 2 were setting-specific, and not evidence that intellectual measures of overconfidence are somehow less socially effective than sporting ones.

Confidence over time

In addition to eliminating non-verbals, the dating profile measure used in Chapter 3 was essentially a one-shot interaction in which individuals attempted to ‘sell themselves’ in an initial meeting. While some commentators have suggested that overconfidence might be at its best in initial interactions, (Paulhus, 1998) it is important to note that sporting overconfidence in Chapter 2 was primarily associated with social benefits a year later, with little evidence that overconfident people were benefitting socially when first measured. This would make sense if confidence tends to be displayed regularly in an individual’s actions over time, rather than conspicuously displayed in any particular interaction. If that is the case, then the extended period of interaction observed in the longitudinal study provides another possible explanation for the different patterns of findings between Chapters 2 and 3. As with nonverbal expressions of overconfidence, further work allowing overconfidence to have social effects over time would help to disambiguate the findings presented here.

Any follow-up studies in either line of investigation would benefit from measuring overconfidence in both an intellectual and a physical arena, to test whether the two continue to have differential effects when overconfidence can be expressed nonverbally and over time, or whether the differences reported in Chapter 2 were specific to the school setting.

Overconfidence, competition, and status

In Chapter 3, although overconfidence was not associated with overall romantic desirability, it did successfully deter competitors. These studies tested the effects of overconfidence in head-to-head romantic competitions, showing that overconfident competitors who displayed more confidence were more willing to engage others in a contest for a romantic partner, and were themselves seen as difficult to compete with, causing potential rivals to back down and look elsewhere for a partner.

This finding is consistent with other research suggesting that individuals can become particularly overconfident when situations are competitive. For instance, overconfidence is highest in countries where economic inequality is also high (Loughnan et al., 2011). One possible reason for this is that in an highly unequal economy, financial rewards are increasingly skewed, such that the benefits of getting to the top of the pile far outweigh the costs of competing (Loughnan et al., 2011). Evolutionary models suggest that overconfidence should be beneficial when it drives people to compete under just these circumstances (D. D. P. Johnson & Fowler, 2011).

If individuals tend to be particularly overconfident in competitive contexts, it may be because it tends to work. The established benefits of overconfidence on status (Anderson et al., 2012; Kennedy et al., 2013; Ronay et al., n.d.) indicate that overconfidence may indeed be particularly beneficial in climbing competitive social ladders. Indeed, although overconfidence did not increase overall perceptions of desirability in the studies reported in Chapter 3, it did increase overall perceptions of status (see Appendix B).

Of course, the finding in Chapter 2 that sporting overconfidence led to increased popularity in a friendship context suggests that competition is not the sole purpose of overconfidence. However, the literature has consistently shown that overconfidence is beneficial in status-driven contexts (Anderson et al., 2012; Kennedy et al., 2013; Ronay et al., n.d.), in sharp contrast to the mixed pattern of findings in other social domains. The literature would benefit from more work testing the effects of overconfidence on perceptions of status and other outcomes simultaneously, to identify whether and why overconfidence truly is particularly beneficial in competitive contexts.

Overconfidence as a latent factor

Previous research has shown that overconfidence is correlated across different domains (Bornstein & Zickafosse, 1999), and in Chapter 2 I found that overconfidence in

intelligence and sport, arguably two very different domains, was still substantially correlated. These findings suggest that different forms of overconfidence may be partially driven by a single underlying factor. Chapter 3 tested this possibility explicitly by treating separate measures of overconfidence as representative of an underlying latent trait. Implicit in this method of representing overconfidence is the idea that individuals differ in the extent to which they possess a general trait for overconfidence, which influences the extent to which they are overconfident in any given domain.

How might such a factor operate? One possibility is that there are stable individual differences in the extent to which people show a number of the cognitive biases described in Chapter 1 (von Hippel, Lakin, & Shakarchi, 2005). If there are correlated, stable individual differences in the tendency to bias our information search to find positive information about ourselves, remember our past performance as better than it was, and see our best efforts as representative of our ‘true’ level of performance, then these could form a latent overconfidence factor that would affect the tendency to form overconfident perceptions across multiple domains.

The possibility of such a latent factor is relevant to the previous discussion about the indirect effects of overconfidence in Chapter 3. In Chapter 3, overconfidence was measured in primarily intellectual domains, and even when construed as a latent factor, the indicators of the latent variable were primarily intellectual. Presumably, the general trait of overconfidence that was tapped by these measures also influenced overconfidence in romantically relevant domains. It is likely that these more relevant forms of overconfidence, which were not measured directly, were primary drivers of the increased perceptions of romantic confidence found throughout the studies reported in Chapter 3.

An interesting possibility for future research would be to measure individual's tendencies to engage in a number of the cognitive biases described in Chapter 1, in an effort

to tap a latent ‘bias factor.’ Presumably, this factor would predict an individual’s scores on a latent factor for overconfidence (similar to the one measured in Chapter 3). If this were the case, it would provide evidence for how overconfident self-perceptions are originally formed, and would also explain why overconfidence is correlated across such disparate domains.

Overconfidence in romantic pursuits as error management

In Chapter 3, agent-based modelling showed that overconfident individuals might benefit romantically under high levels of competition because they are less likely to bow out of the fight. Extending this line of thinking, an additional benefit can be hypothesised by considering an individual’s willingness to approach partners (absent competition) of differing mate value. Work on the ‘matching hypothesis’ suggests that one way individuals end up with a partner of similar mate value to themselves is that they approach individuals of progressively lower mate value until their interests are reciprocated (L. S. Taylor, Fiore, Mendelsohn, & Cheshire, 2011). In error management terms, the more costly error that individuals can make here is to start by approaching people who are too low in mate value, thus settling for less than the best match available. It is possible that overconfident individuals, in addition to being more willing to compete for romantic partners, might also be more willing to approach romantic partners of higher mate value. If so, it suggests another avenue by which overconfidence might provide a romantic benefit – by causing individuals to approach people who may be ‘out of their league’, overconfidence could ensure that these individuals don’t settle for less than they can get. Further work could examine willingness to approach romantic partners (rather than willingness to compete for them) as a function of the attractiveness of the romantic partner, to see if overconfidence works in such a manner.

The benefits of having overconfident friends

In Chapter 2, sporting overconfidence led to an increase in popularity over time. This outcome is necessary for social accounts of overconfidence to be truly adaptive; it would not do much good to gain friends through your increased confidence only to lose them later. However, it is worth considering how overconfidence could create sustained popularity, given that some commentators have suggested that friends repeatedly challenge our abilities, and would inevitably detect and ‘burst our bubble’ if we were overconfident (Frey & Volland, 2011).

Presuming that our friends eventually know us well enough to divine our true ability, why would overconfident self-perceptions continue to generate social benefits? One possibility is that our friends may not be motivated to ‘burst our bubble’ of overconfidence after all. In reality, people may gain little from puncturing the positive illusions of friends and romantic partners. This is especially true if these illusions are maintained at levels that are not overly unrealistic and thus not likely to have substantial costs. To the extent that overconfidence can increase performance, or attract further social connections, we may in fact benefit from having friends and partners with positive illusions, as it is generally in our best interests that our friends and romantic partners are successful.

Indeed, it is even possible that friends may engage in reciprocal fostering of positive illusions, bolstering each other's self-images so that each may gain the benefits of an overconfident self-view that is regularly reinforced (Krebs & Denton, 1997). Research has shown that people use some of the cognitive biases discussed in Chapter 1 to maintain their positive perceptions of romantic partners and close friends, not just themselves (Epley & Whitchurch, 2008; Thai & Lockwood, 2015). In romantic relationships (and probably in friendships as well), these positive perceptions can help to bolster others’ perceptions of themselves, potentially creating a mutually beneficial cycle of reinforcing each other’s

overconfidence (Murray, Holmes, & Griffin, 1996). Thus, rather than being a harsh circle of critics waiting to pop our overconfident bubbles, friends might represent a source of reinforcement for our overly positive self-views, which would account for the sustained effects of overconfidence on popularity in Chapter 2.

The manipulation of overconfidence

While the longitudinal approach of Chapter 2 helps to speak to the directionality of the observed effects of overconfidence, the causality of overconfidence cannot be established with certainty without an experimental manipulation. One way in which overconfidence has been manipulated previously is the use of false feedback – giving participants more positive performance feedback than they have earned in order to induce them to hold more positive perceptions of their ability than are justified by reality (Anderson et al., 2012; Tenney et al., 2015). From a philosophical standpoint, however, it is unclear to what extent these inductions really create overconfidence, at least as I have defined it.

These individuals clearly have more positive perceptions of themselves than are justified by reality, but given that they had no chance to gain accurate feedback, can it really be said that they view themselves ‘more positively than is warranted by an unbiased assessment of reality’? After all, if I take a test, and am told by an experimenter that I performed well, an unbiased assessment of reality would be to think that I am good at the task. By manipulating overconfidence, therefore, what may really be created could best be described as ‘unjustified confidence’, or confidence in the absence of ability. There are many interesting questions about how confidence affects outcomes independent of ability. However, manipulating overconfidence in this way assumes that naturally occurring overconfidence would lead individuals to feel their confidence as deeply and strongly as if it were perfectly justifiable, something that is still an open question.

Is there any way that overconfidence itself can be manipulated? One possibility may be to manipulate the extent to which individuals have the opportunity to *become* overconfident, without forcing them to do so. For instance, drawing on the biased information search literature discussed in Chapter 1, one way to manipulate overconfidence might be to have individuals read a set number of statements providing feedback on some aspect of themselves. The experimental manipulation would be varying whether people have knowledge of the likelihood that each statement is positive. Presumably, when this knowledge is available, people in the experimental condition will tend to use it to bias their information search and create overly positive images of themselves. The individuals in this condition would thus be more overconfident than those in the control group, and in particular, still more confident than could be attributed to an unbiased assessment of reality. Work using such a paradigm has the potential to provide unique insights into the causal effects of overconfidence.

Unanswered questions

The primary limitation of the research presented in this thesis has been that it is difficult to interpret the difference in the findings that emerged across, and indeed within, the two empirical chapters. Because data collection in Chapter 2 took place as part of a larger project, it was not possible to include as many measures as one would like. Ideally, multiple methods of measuring overconfidence in each domain, as well as measures of the perceptions of people's friends, would have helped to explain why overconfidence in sport was beneficial when overconfidence in intelligence was not. Is it the case the overconfidence in physical attributes is generally more socially effective than intelligence overconfidence and would have shown larger benefits in a romantic setting as well? Or was intelligence overconfidence ineffective in Chapter 2 for other reasons, with the differences between chapters indicating

that the effects of overconfidence differ across social domains, or that overconfidence takes a longer timeframe to effect social change?

Unfortunately, the challenges of collecting longitudinal data in a school setting make follow-up work to disambiguate these possibilities in that setting unlikely. However, further work on overconfidence in the romantic domain should prove informative, especially if the ideas presented here about manipulating overconfidence are incorporated. Such work may show that most forms of overconfidence have a positive effect on desirability, and that intellectual overconfidence is an anomaly. Additionally, it might show that overconfidence leads to more desirability only when expressed in person, or when allowed to work over time. A pattern of findings such as this would suggest that the social benefits of sporting overconfidence found in Chapter 2 are broadly representative of the effectiveness of overconfidence in creating positive social outcomes.

Concluding remarks

While overconfidence in our modern world creates a host of ills, this thesis investigated the potential benefits that may make it worthwhile – at least to those wielding it. The research presented herein advanced the existing literature by testing the three major hypotheses for an adaptive function of overconfidence – mental health, social, and motivational benefits – in a single, longitudinal study. It also furthered the search for a social function to overconfidence with the first tests of the effects of overconfidence on real-world popularity, romantic desirability and romantic competition. Though the findings are qualified by the preliminary nature of these investigations, the work presented in this thesis converges to suggest that overconfidence may indeed be so prevalent in humans because it provided our ancestors with adaptive advantages; advantages it continues to provide us to this day.

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Appendix A: Supplementary Tables for Chapter 2

Table 13.

Effect size of Time 1 sporting overconfidence on Time 2 in-degree, with and without controlling for Time 2 sporting ability. The sample for which Time 2 sport is available is small, so the effect is not significant to start with, but there is no evidence that the effect changes in size as Time 2 ability is added.

Outcome variable	Sport					Adjusted R ²
	Time 1 value	Overconfidence	Time 1 ability	Time 2 ability	df	
Time 2 in-degree	.63*** [.45, .81]	.06 [-.07, .20]	.07 [-.11, .24]		162	.25
Time 2 in-degree	.64*** [.47, .83]	.07 [-.06, .21]	.13 [-.12, .38]	-.07 [-.28, .14]	161	.24

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

Table 14.

Standardized Betas and Confidence Intervals when predicting GPA at Time 2 from GPA at Time 1 within only the subset of classes that individuals took in both years. For this purpose, overconfidence is indexed by comparing self-ratings to the Allwell and Time 1 GPA only.

Outcome variable	Intelligence				Adjusted R ²
	Time 1 GPA	Overconfidence	Allwell	df	
Time 2 GPA	.78*** [.73, .83]	.05* [.01, .08]	.14*** [.10, .19]	670	.78

* $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

Appendix B: Supplementary Online Material for PSPB publication associated with Chapter 3

Example profiles

Throughout our paper we discuss the arrogance and confidence of the written dating profiles we collected. Here we show a pair of (slightly abbreviated) example profiles to give readers an idea of what the raters in our study saw.

This first profile is a prototypical ‘high arrogance’ profile (the highest arrogance profile for Study 2, in fact). This profile was rated 3.75 on arrogance, on our 1 to 4 scale.

“I am a very simple man. I want what I want when I say I want it. Image is very important to me so hot messes need not apply. I work hard and am very dedicated to my career if you can't handle that or are co-dependent to a fault I am not the guy for you. Because I work hard, time with my boys to unwind and relax is essential. I will not spend every night going through ikea catalogs with you or watching Sandra Bullock movies on my Friday night. If you're a girl who can handle your own or better yet my own send me a message.”

This second profile is a prototypical ‘confident without being arrogant’ profile. It scored 3.55 on confidence, but only 1.73 on arrogance.

“I rap, I dance, I live. I am the fullest extension of God's imagination. I am the core of all that is cool. Nah, I'm just a young man circling his way through life, trying to find happiness in the pages of a notebook; and I'm fine with that. I grew with an absent, alcoholic father who, in my own words, showed me what not to do in life - and as much as it pains me to admit, for that, I thank him. Living most of my life without, I plan on making something of myself, undoubtedly. Whether it's at an office, me slowly dying, or living my wildest dreams,

I plan to support my family regardless of situation. That, in itself, should show what kind of man I am.”

Gender Moderations

While no individual predictor was moderated by gender in any of the individual regression analyses in our paper, we also performed multi-group SEM analysis by gender. In Studies 2 and 4, we found that when we tested the moderated effects of all pathways in the model simultaneously, the pathways from arrogance and confidence to desirability were moderated by gender in the multi-group analysis. Upon further investigation, we found that this moderation only occurred when both arrogance and confidence were allowed to vary by gender at the same time. The effects of confidence on desirability are not moderated by gender (even when controlling for arrogance), and the same is true for the effects of arrogance on desirability (even when controlling for confidence). Rather, only the combined effects of confidence and arrogance are moderated by gender – it seems that the suppression effect is more extreme for males than females, resulting in a stronger positive effect of confidence but also a stronger negative effect of arrogance for males – when the two are entered as predictors at the same time. Because these are competing paths, there is no overall difference between genders in the sum effect of arrogance and confidence (or the effects of overconfidence). We report the multi-group analyses below.

Study 1

Multi-group analysis revealed that gender of the author did not moderate the effects of overconfidence on confidence or desirability, nor the effects of confidence on desirability ($\chi^2 (3) = 3.60, p = .301$).

Study 2

Multi-group analysis revealed that the regression paths in the model were not invariant across gender ($\chi^2 (4) = 16.26, p = .003$). Follow-up tests revealed that the effects of both arrogance ($\chi^2 (1) = 13.10, p < .001$) and confidence ($\chi^2 (1) = 11.18, p < .001$) on desirability differed across genders, such that both had stronger effects for males in the full model. That is, arrogance had a more negative effect for males ($B = -.811, p < .001$) than females ($B = -.413, p < .001$), and confidence had a more positive effect for males ($B = .753, p < .001$) than females ($B = .431, p < .001$).

Study 4

Multi-group analysis showed first that the overconfidence latent variable was factor invariant ($\chi^2 (3) = 3.75, p = .289$) across genders (i.e. the loadings of each indicator were the same for men and women). Subsequent analysis revealed that regression paths in the model were not invariant across gender ($\chi^2 (1) = 13.72, p = .008$). Follow-up tests revealed that the effects of both arrogance ($\chi^2 (1) = 11.01, p = .001$) and confidence ($\chi^2 (1) = 8.29, p = .004$) on desirability differed across genders, such that both had stronger effects for males in the full model. That is, arrogance had a more negative effect for males ($B = -.523, p < .001$) than females ($B = -.358, p < .001$), and confidence had a more positive effect for males ($B = .805, p < .001$) than females ($B = .625, p < .001$).

The unique role of overconfidence

The primary focus in the desirability portion of our paper was on whether overconfidence would lead to increased perceptions of confidence, and whether this confidence would increase perceptions of romantic desirability. However, in the course of our studies we also asked raters to judge several other traits generally associated with desirable romantic partners (social status, intelligence, humour, creativity). Given the goal of our paper, these variables can answer some interesting questions.

In our paper we propose that a key way in which overconfidence could create a positive impression is through the confident behavior it creates. A competing hypothesis might be that overconfidence simply makes others view us more positively (through unknown means), and that confidence, social status, intelligence, humour, and creativity are all different measures of a single ‘positivity’ construct, which mediates the effects of overconfidence on desirability. If this were the case, any of our positively worded variables would mediate the effects of overconfidence in the same way that confidence does. A stronger version of the same competing hypothesis might propose that romantic desirability is also a measure of this ‘positivity’ construct, and that signs of mediation are simply artefacts of shared variability among measures that tap the same construct.

We ran several confirmatory factor analyses to test this competing hypothesis. First, we tested whether the five ‘positive’ variables (confidence, humour, intelligence, creativity, and social status) could be fit to a single-factor model. The fit statistics of such a model (chi squared = 862.15, $df = 6$, $p = 0$, CFA = .510, TLI = .183, RMSEA = .359) indicate extremely poor fit, rejecting a single-factor model. Adding desirability to this ‘positivity’ factor did not improve the fit (chi squared = 972.52, $df = 10$, $p = 0$, CFA = .644, TLI = .466, RMSEA = .295). We also tested the less conservative hypothesis that four of our more conceptually related positive variables (desirability, confidence, intelligence, and social status) could be fit to a single factor. This model also had resoundingly poor fit (chi squared = 610.97, $df = 3$, $p = 0$, CFA = .656, TLI = .312, RMSEA = .428). These confirmatory factor analyses provide strong statistical evidence that our rating variables cannot be reduced to just one ‘positivity’ factor. Given the convergence of the statistical evidence with the conceptual variation of our rating variables, it seems unlikely that there is a single positivity factor present in our data. With regard to confidence and desirability specifically, our measure of arrogance provides additional evidence that these are conceptually distinct variables. While confidence is

positively correlated with both arrogance ($r = .44$, $p < .001$) and desirability ($r = .43$, $p < .001$), desirability is correlated negatively with arrogance ($r = -.23$, $p < .001$). This suggests that confidence represents a nuanced construct, separate from desirability, which has elements in common with arrogance (a negative trait) but is nonetheless seen overall as a positive trait.

Despite the lack of a general positivity factor, it would still weaken our argument for a unique role of confidence if our other positively worded variables were equally apt mediators of the effects of overconfidence on desirability. However, no other positively worded scale could take the place of confidence as a (significant) mediator across all of our studies. Confidence is significantly predicted by all overconfidence measures across our 3 empirical studies, and thus can statistically mediate the effects of overconfidence across all studies. None of the other positive variables (social status, intelligence, creativity, humour) show the same consistent pattern of correlations. These findings support our proposal that positive effects of overconfidence are largely due to other individuals perceiving overconfident people as more confident and ascribing other positive internal traits as a consequence.

Analyses with other trait ratings (social status, humour, etc) as outcomes

As we propose that people ascribe other positive internal traits to those who are confident, it is possible that overconfidence has effects, though confidence, on perceptions of positive traits other than romantic desirability. Here we present the results of analyses substituting each of the other positive traits we measured (social status, humour, intelligence, and creativity) in the place of romantic desirability in Studies 1, 2 and 4. These analyses test whether overconfidence affected these variables through increased confidence, and in the case of studies 2 and 4, increased arrogance.

From the analyses below, it can be seen that intelligence, humour, and creativity show similar patterns to romantic desirability, with the exception that these variables seem to be affected slightly more positively by the combination of confidence and arrogance, leading to significant (if small) positive indirect effects of overconfidence in Study 4. In contrast, social status shows a substantially different pattern. In Studies 2 and 4, there is no negative effect of arrogance on social status, leading to significant positive total effects of overconfidence on social status. It seems that arrogance does not reduce the perception of high social status. This provides one possible explanation for the differences we highlight in our general discussion between our findings on romantic desirability and previous competence-based findings, though further research would be needed to test this possibility.

Intelligence

In Study 1, mediation analyses showed that authors' overconfidence indirectly predicted how intelligent raters found them through confidence as a mediator ($IE = .12, p = .002$). There was no direct effect of authors' overconfidence on how intelligent they were seen in the presence of the mediated pathway ($DE = .11, p = .117$). There was, however, a significant total effect of overconfidence on perceptions of intelligence ($TE = .23, p = .002$), which mirrored the significant zero-order relationship between the two (see Table 1 in paper).

In Study 2, the model with intelligence as a dependent variable provided a good fit to the data, $\chi^2(1, N = 438) = 2.09, p = .149, \chi^2/df = 2.09$; CFI = 1.00; RMSEA = .050; SRMR = .019. The extent to which authors were seen as confident was positively associated with the extent to which they were seen as intelligent ($DE = .48, p < .001$), while arrogance was negatively associated with intelligence ($DE = -.28, p < .001$). Overconfidence had a positive indirect association with intelligence, mediated through confidence ($IE = .06, p = .019$), and a negative indirect association with intelligence mediated through arrogance ($IE = -.05, p =$

.002). Due to the countervailing influence of these two effects, overconfidence had a null total indirect association with intelligence ($TE = .01, p = .741$).

In Study 4, The model with intelligence as a dependent variable provided acceptable fit to the data, $\chi^2 (7, N = 1108) = 23.88, p = .001, \chi^2/df = 3.41$; CFI = 0.98; RMSEA = .047; SRMR = .033. Examination of the indirect effects of overconfidence on intelligence revealed a positive indirect association through confidence ($IE = .07, p = .001$) and a negative indirect association through arrogance ($IE = -.02, p = .036$), resulting in a positive indirect association overall ($TE = .04, p = .017$).

Humour

In Study 1, mediation analyses showed that authors' overconfidence indirectly predicted how humorous raters found them through confidence as a mediator ($IE = .11, p = .002$). There was no direct effect of authors' overconfidence on how humorous they were seen in the presence of the mediated pathway ($DE = -.06, p = .369$). There was, however, no total effect of overconfidence on perceptions of humour ($TE = .05, p = .532$), which mirrored the non-significant zero-order relationship between the two (see Table 1 in paper).

In Study 2, the model with humour as a dependent variable provided a good fit to the data, $\chi^2 (1, N = 438) = 0.00, p = .947, \chi^2/df = 0.00$; CFI = 1.00; RMSEA = .000; SRMR = .001. The extent to which authors were seen as confident was positively associated with the extent to which they were seen as humorous ($DE = .30, p < .001$), while arrogance was negatively associated with humour ($DE = -.18, p = .001$). Overconfidence had a positive indirect association with humor, mediated through confidence ($IE = .04, p = .026$), and a negative indirect association with humour mediated through arrogance ($IE = -.03, p = .012$). Due to the countervailing influence of these two effects, overconfidence had a null total indirect association with humour ($TE = .00, p = .803$).

In Study 4, The model with humour as a dependent variable provided a relatively good fit to the data, $\chi^2 (7, N = 1108) = 16.72, p = .019, \chi^2/df = 2.39$; CFI = 0.99; RMSEA = .035; SRMR = .028. Examination of the indirect effects of overconfidence on humour revealed a positive indirect association through confidence ($IE = .04, p = .001$) and a negative indirect association through arrogance ($IE = -.01, p = .044$), resulting in a positive indirect association overall ($TE = .03, p = .013$).

Creativity

In Study 1, mediation analyses showed that authors' overconfidence indirectly predicted how creative raters found them through confidence as a mediator ($IE = .15, p = .021$). There was no direct effect of authors' overconfidence on how creative they were seen in the presence of the mediated pathway ($DE = .04, p = .546$). There was, however, a significant total effect of overconfidence on perceptions of creativity ($TE = .18, p = .014$), which mirrored the significant zero-order relationship between the two (see Table 1 in paper).

In Study 2, the model with creativity as a dependent variable provided a good fit to the data, $\chi^2 (1, N = 438) = 0.33, p = .567, \chi^2/df = 0.33$; CFI = 1.00; RMSEA = .000; SRMR = .008. The extent to which authors were seen as confident was positively associated with the extent to which they were seen as creative ($DE = .38, p < .001$), while arrogance was negatively associated with creativity ($DE = -.23, p < .001$). Overconfidence had a positive indirect association with creativity, mediated through confidence ($IE = .04, p = .021$), and a negative indirect association with creativity mediated through arrogance ($IE = -.04, p = .005$). Due to the countervailing influence of these two effects, overconfidence had a null total indirect association with creativity ($TE = .01, p = .782$).

In Study 4, The model with creativity as a dependent variable provided a marginal fit to the data, $\chi^2 (7, N = 1108) = 33.18, p < .001, \chi^2/df = 4.74$; CFI = 0.97; RMSEA = .058; SRMR = .038. Examination of the indirect effects of overconfidence on creativity revealed a

positive indirect association through confidence ($IE = .06, p = .001$) and a negative indirect association through arrogance ($IE = -.02, p = .036$), resulting in a positive indirect association overall ($TE = .04, p = .027$).

Social status

In Study 1, mediation analyses showed that authors' overconfidence indirectly predicted how high in social status raters found them through confidence as a mediator ($IE = .16, p = .001$). There was no direct effect of authors' overconfidence on how high in social status they were seen in the presence of the mediated pathway ($DE = .10, p = .100$). There was, however, a significant total effect of overconfidence on perceptions of social status ($TE = .26, p < .001$), which mirrored the significant zero-order relationship between the two (see Table 1 in paper).

In Study 2, the model with social status as a dependent variable provided a good fit to the data, $\chi^2 (1, N = 438) = 2.11, p = .147, \chi^2/df = 2.11$; CFI = 1.00; RMSEA = .050; SRMR = .019. The extent to which authors were seen as confident was positively associated with the extent to which they were seen as high in social status ($DE = .46, p < .001$), while arrogance was not associated with social status ($DE = .00, p = .977$). Overconfidence had a positive indirect association with social status, mediated through confidence ($IE = .05, p = .019$), and a negative indirect association with social status mediated through arrogance ($IE = .00, p = .977$). Because arrogance had no negative effect on social status, in contrast to previous findings, overconfidence had a positive total indirect association with social status ($TE = .05, p = .022$).

In Study 4, The model with social status as a dependent variable provided an acceptable fit to the data, $\chi^2 (7, N = 1108) = 3.52, p = .001, \chi^2/df = 2.57$; CFI = 0.98; RMSEA = .048; SRMR = .034. Examination of the indirect effects of overconfidence on social status revealed a positive indirect association through confidence ($IE = .07, p = .001$) and a

negative indirect association through arrogance ($IE = .00, p = .114$), resulting in a null indirect association overall ($TE = .07, p = .001$).

Binomial regressions for table choice outcomes

As our table choice outcome consisted of a dichotomous judgement repeated 5 times by each competitor, it can be considered count, or proportion data. Such data sometimes violates the assumptions of ordinary least squares regression (on which our SEM models are based). Our table choice data are best described as binomial - the number of ‘successes’ across a fixed, modest number of N trials. While the binomial distribution approaches the normal distribution as more trials are drawn, making violations of the assumptions of ordinary least squares less likely, our table choice task does not contain enough trials for this to be unambiguously the case.

Unfortunately, these data cannot be modeled in an appropriate fashion in any SEM program of which we are aware. Because each author was ‘competed’ against a varying number of times, we cannot compare counts of how often they were competed with. Instead we have, for each author, proportions (percent of competitors who competed) that must be weighted by the number of observations they are based on (number of competitors who rated the author). This form of proportion data does not appear to be fully supported in any SEM package at this time. It is for that reason that we have reported our OLS-based SEM results in the paper. However, as simple binomial regression with proportion-based data can be easily tested, we present below comparisons of OLS (standard) regressions with these binomial regressions, testing all of the paths that directly predict table choice outcomes in Studies 3 and 4. We report regressions that simultaneously include predictors that were at the same ‘stage’ of our SEM (e.g., arrogance and confidence are entered together, unpleasant and difficult are entered together).

As we show below, there are no substantive differences between OLS regression and binomial regression for this data. Thus, there is no obvious basis to suspect any issues with results derived from our OLS-based SEM of table choice.

Study 3: Author's deterring competition

OLS regression. Authors' perceived unpleasantness had no effect on competition ($B = .01, p = .205$), while authors perceived as difficult were competed against less ($B = -.40, p < .001$). Confident authors were competed against less ($B = -.24, p < .001$), while authors' arrogance did not have an effect ($B = -.02, p = .685$).

Binomial regression. Authors' perceived unpleasantness had no effect on competition ($B = .11, p = .061$), while authors perceived as difficult were competed against less ($B = -.43, p < .001$). Confident authors were competed against less ($B = -.26, p < .001$), while authors' arrogance did not have an effect ($B = .01, p = .817$).

Study 4: Author deterring competition

OLS regression. Unpleasant authors were competed against more ($B = .31, p < .001$), while difficult authors were competed against less ($B = -.51, p < .001$). Confident authors were competed against less ($B = -.45, p < .001$), while authors' arrogance did not have an effect ($B = .08, p = .074$).

Binomial regression. Unpleasant authors were competed against more ($B = .36, p < .001$), while difficult authors were competed against less ($B = -.57, p < .001$). Confident authors were competed against less ($B = -.50, p < .001$), while authors' arrogance did not have an effect ($B = .07, p = .089$).

Study 4: Competitor's increased competition

OLS regression. Competitors perceived as more confident were more likely to compete ($B = .24, p < .001$), while the perceived arrogance of competitors did not have an effect ($B = -.03, p = .448$).

Binomial regression. Competitors perceived as more confident were more likely to compete ($B = .33, p < .001$), while the perceived arrogance of competitors did not have an effect ($B = -.03, p = .473$).

Direct overconfidence pathways

Structural equation models throughout this paper include direct paths from overconfidence only to arrogance and confidence, in keeping with our theoretical model that these variables will mediate any influence of overconfidence. Consistent with this logic, adding direct effects from overconfidence to other DVs does not change the direction of reported effects across any of the six structural equation models we report, and in only one of these models does the significance of any reported effects change.

In this model, (Study 4 examining the effect of author overconfidence on competitors willingness to compete; see Figure 5), the direct effect of overconfidence on unpleasantness (but not difficulty) remains significant with arrogance and confidence in the model ($DE = .14, p = .004$), and the addition of these direct effects to the model changes the significance of the total indirect effect ($IE = -.03, p = .191$ instead of $IE = -.05, p = .002$). We note that the added direct effect of overconfidence on unpleasantness is *not* significant in Study 3, and so this association is inconsistent across studies - thus, we retain our *a priori* theoretical model whereby confidence and arrogance serve as sole mediators of the effects of overconfidence.

Dichotomous desirability variable results

As part of Study 4, we asked raters “given the information presented, would you be willing to consider a date (with the author) if they approached you?” This question was primarily included to provide a measure of actual willingness to say ‘yes’ to the approaching individuals for our modelling in Study 5. Below, we report the results of the Study 4 desirability analysis with the dichotomous choice variable (averaged to represent the

percentage of raters who say ‘yes’ to the author) replacing the 1 to 7 romantic desirability scale reported in the paper.

The three overconfidence measures were entered as observed variables loading onto a latent overconfidence variable. The model provided a relatively good fit to the data, $\chi^2 (7, N = 1108) = 18.59, p = .010, \chi^2/df = 2.57$; CFI = 0.99; RMSEA = .039; SRMR = .025. The latent overconfidence factor predicted raters’ perceptions of the confidence ($DE = .12, p = .002$) and arrogance ($DE = .07, p = .046$) of the profiles. Examination of the indirect effects of overconfidence on willingness to consider a date revealed a positive indirect association through confidence ($IE = .06, p = .002$) and a negative indirect association through arrogance ($IE = -.04, p = .047$), resulting in a null indirect association overall ($TE = .02, p = .220$).

As mentioned above for table choice outcomes, this dichotomous desirability outcome is binomial in nature. Thus, we again present a comparison of OLS and binomial regression for the paths leading to the dichotomous choice variable, to show that there are no substantive differences:

Study 4: Authors’ desirability using a dichotomous measure

OLS regression. Authors perceived as more confident were more likely to be found acceptable for a date ($B = .47, p < .001$), while those perceived as arrogant were less likely to be found acceptable ($B = -.47, p < .001$).

Binomial regression. Authors perceived as more confident were more likely to be found acceptable for a date ($B = .44, p < .001$), while those perceived as arrogant were less likely to be found acceptable ($B = -.44, p < .001$).